GRADUATE STUDENTS' COLLABORATIVE INFORMATION SEEKING IN A

GROUP-BASED LEARNING SETTING

Jisu Lee

Dissertation Prepared for the Degree of

DOCTOR OF PHILOSOPHY

UNIVERSITY OF NORTH TEXAS

May 2013

APPROVED:

Linda Schamber, Major Professor
Jeonghyun Kim, Co-Major Professor
Yunfei Du, Committee Member
Herman L. Totten, Dean of the College of
    Information
Mark Wardell, Dean of the Toulouse
    Graduate School

Lee, Jisu. <u>Graduate Students' Collaborative Information Seeking in a Group-Based Learning Setting.</u> Doctor of Philosophy (Information Science), May 2013, 166 pp., 22 tables, 16 figures, references, 74 titles.

Working with others within an organization can have a variety of positive effects, and the benefits of collaboration have been discussed in various disciplines. In information science, interest in collaborative information seeking, including collaborative information seeking by students in an online learning environment is expanding.

This study was aimed at understanding graduate students' collaborative information seeking behaviors through the process of a group project, including factors that affected students' perceptions of collaborative work and their difficulties during the collaborative process. The research was based on Yue and He's model, which describes information users' collaborative communication and information behaviors, and Kuhlthau's model, which describes users' individual information seeking behaviors.

The participants were 43 students enrolled in a master's level course delivered primarily online. The students were required to work together in groups to complete a research project. Data were collected through a background survey, behavior survey, and online communication texts and analyzed using descriptive statistics, statistical tests, and content analyses. The results showed significant changes in collaborative and information seeking behaviors and perceptions across three stages of the project during the semester. Theoretical, practical, and methodological implications for future research are discussed.

Copyright 2013

by

Jisu Lee

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1   Introduction

We are living in information-rich environments with rapidly transforming technology,

different and enormous information sources, and highly specialized content. Such complex

interaction does not guarantee that an individual will access the most consistent or relevant

information and use it appropriately to work out problems. So when we are faced with complex

problems, it is natural to work together with others to solve them more easily and effectively.

Kuhlthau (1993) stated that the process of information search is not an isolated activity, and may

be considered as a cooperative venture with peers or librarians as collaborators. In addition,

collaborative approaches to research produce better and more efficient results than individual

approaches in a variety of domains. Humans are social beings with a natural tendency toward

collaboration, as seen in a growing body of evidence on collaborative efforts in today's

information-based society (Shah, 2010). This study examined students' collaborative information

seeking in a group-based learning environment.

1.2   Background

Working with others within an organization can have a variety of positive effects, and the

benefits of collaboration have been discussed in various areas. For example, in the workplace,

collaborative workers benefit from the diverse contributions of members with different

backgrounds, roles, attitudes and interests, all of whom contribute to the richness of the

cooperative effort (Baeza-Yates & Pino, 2006). In a library and information science (LIS) study,

Talja (2002) identified the advantages of collaborative information seeking activities between academic scholars. She said that individuals in group projects seem to engage in more strategic and paradigmatic sharing. Thus, it would seem that group works offer individuals more potential for cooperative approaches to seeking and sharing information. In educational studies, many researchers also have emphasized the benefits of collaborative work with peers within the learning environment. For instance, Gokhale (1995) said that collaborative learning between peers promotes the active exchange of ideas and increases interest and critical thinking among students. Johnson and Johnson (1986) also emphasized that learners in collaborative groups are able to attain higher levels of attention and remember information longer than individual learners. In addition, with the knowledge shared in teams, students can participate in group discussions and take responsibility for their own learning as critical thinkers (Totten, Sills, Digby, & Russ, 1991). Moreover, collaboration can be a useful method for promoting learners' knowledge construction (Schellens & Valcke, 2006).

The approaches of collaborative information behavior (CIB), collaborative information seeking behavior (CIS), and collaborative information retrieval (CIR) have been grounded in the research of information seeking behavior; therefore, they also have been focused on information behavior that involves human beings interacting with other humans. There are various meanings of collaboration in the activities of information seeking and retrieval in LIS studies. The term "CIS" is used interchangeably with terms such as CIB and CIR in many cases. In general, CIB includes people's intricate process of activities to resolve their information needs (Talja & Hansen, 2006), and CIS means not only collaborative information seeking, but also sharing, understanding, and using information in collaboration (Paul & Reddy, 2010). Accordingly, the process of seeking, organizing, and using information has also been viewed as meaningful

collaboration. For example, Bruce, Fidel, Pejtersen, Dumais, and Grudin (2003) focused on situations where a group of people are seeking, searching, and using information collaboratively. They believed that information seeking is not always a solitary activity, and that people tend to work in collaborations for information-intensive tasks. Also, Morris (2008) found that most knowledge workers have the desire to search for information together in their workplace. In addition, they thought that CIS activities are essential for the success of their dynamic and specialized work tasks. Through CIS, people can identify their information problems or needs and solve their common goals.

As the amount of collaborative work being undertaken is growing in various fields, from the workplace to LIS and education, it is important that this topic area is studied by research based on collaborative practices to understand problems and suggest improvements. In LIS, the use of collaborative information seeking in a learning environment is expanding among students as a form of group research projects. In particular, collaboration in higher education has presented many advantages to the learning environment. Effective CIS in a learning environment allows for promoting students' academic motivations, deeper understanding of the subject, and overall perceptions of success. Also, the facility of collaboration, such as a relatively safe setting, enables students' development of the ability to collaborate in their group work (Meloche & Dalton, 2011). Despite the fact that a number of students have worked together on group projects and in collaboration and this has been shown to increase the learning and retention of information, instructors and academic librarians may have mostly overlooked the growing importance of collaborative activities in learning environments since there has been little research in this area.

1.3   Problem Statement

    In the learning environment, there have been some difficulties with collaborative activities among learners. One of the major difficulties with incorporating collaborative activities into learning environments may be controlling the relationship between the instructor and students. Panitz and Panitz (1998) found that current learning systems focused on encouraging competition and individual responsibility between students and discouraged interactions between students. However, collaborative activities in learning environments help to reestablish the relationship between students and instructors by offering a supportive environment, such as computer-supported communication tools. Curtis and Lawson (2001) explained that there are many different ways of interaction among students in collaborative learning, such as giving and receiving feedback or help, sharing knowledge, and exchanging resources and information, and that interaction play an important role in collaborative information seeking activities and learning. As a result of the interaction, such as peer sharing, review and correction, deeper learning may be able to occur within each member in collaborative information seeking activities and learning. However, some students may experience anxiety when interacting with peers and instructors during their learning as a team, while some students may feel isolation when they do not engage in any interaction in their collaborative learning. In addition, collaborative learning is a student-centered process rather than instructor-centered, so students may need a deeper understanding of the subject they are learning in order to be able to engage in peer interaction.

1.4   Purpose of Study

    This study was aimed at understanding graduate students' collaborative information seeking and use throughout the process of a group project, what difficulties students experience

in each stage of the process and which factors affect the students' experience in collaborative work, using the frameworks outlined in Yue and He's CIB model, which describes the users' information behaviors in collaboration, and Kuhlthaus' information search process (ISP) model, which describes the users' overall activities in the process of information seeking. The group assignment performed in this study was a curriculum-based research project to present students' understanding about a research topic. The process of the research project was divided into three stages based on the Student Learning through Inquiry Measure (SLIM) toolkit developed by Todd, Kuhlthau, and Heinstrom (2005): initiation, mid-point, and completion.

Based on previous collaborative information studies, this study assumed that information seeking behavior in collaborative work is not just individual information seeking behavior; rather, it is embedded in other factors, such as context of tasks, cognitive aspects, and various social interactions. These factors may affect students' information seeking activities, including seeking and using information, as well as the overall outcome of the problem-solving process. In addition, the information research process may be perceived differently by its performers or may be affected by the situations in which they are engaged.

In accord with Yue and He's (2010) study, the focus of this study was on the relationships among participants' information activities, perceptions of collaboration levels, types of support needed, and other factors (e.g., cognitive and social factors). The cognitive factors included students' perceived knowledge of the research topic and perceived difficulty of the project. In addition, as a social factor, different degrees of familiarity with group members existed variously in each process of a collaborative work task in Yue and He's CIB model, which may be related to students' perceptions of collaboration levels in their group-based learning. Also, since this study was conducted within an embedded setting, certain background factors, such as student

demographics (i.e., degree program, gender) and previous experience in group work may influence their information seeking activities and perceptions of the collaborative activities.

1.5   Significance of Study

This study was intended to make both theoretical and practical contributions to the literature. One aim related to the underlying theoretical models. The idea was to explain how group members seek and use information based on the ISP model (Kuhlthau, 2004) during three stages of the research project. In particular, this study explored several factors, including cognitive and social aspects that may be related to group members' information seeking process, as well as perceptions of collaboration levels and types of supports needed from peers during the work task process. In addition, this study identified details of how group members manifest their information behavior and perceptions differently during each group task process.

The CIB model (Yue & He, 2010) was selected because it explains interactions among collaboration levels, types of supports needed, stages of information activities, cognition, and task difficulty in collaborative information search tasks. The context of this study, students' information seeking activities in a group-based research project, was different from contexts addressed by Yue and He. Therefore, the results of this study reflected application of CIS theory in an educational setting and helped validate the explanatory power of the model in a different context.

Another aim of this study was to provide practical support for collaborative activities in learning environments, especially in higher education. In order to better understand students' problems, practitioners would benefit from more deeply discussing how students actually seek and use information together and how they perceive their collaboration and interaction with

peers in group-based learning. Also, there may be some additional dimensions, including cognitive and social aspects, to consider with regard to group-based projects, since the factors can be significant criteria for students' willingness and perceptions in collaborative learning. Therefore, a better understanding of collaborative learning could be helpful to instructors and academic librarians in designing effective collaborative course projects, information literacy systems, and library services.

1.6   Research Questions

To understand collaborative information seeking by graduate students during their group project, this study explored the following research questions:

1.   In which ways do group members exhibit information seeking activities throughout the group-based research project?

1.1 How are the cognitive factors related to group members' information seeking activities throughout the group-based research project?

1.2 How are the social factors related to group members' information seeking activities throughout the group-based research project?

2. In which ways do group members have different perceptions of collaboration levels throughout the group-based research project?

2.1 How are the cognitive factors related to their perceptions of collaboration levels?

2.2 How are the social factors related to their perceptions of collaboration levels?

3. In what ways do group members require collaborations or supports from peers to solve their difficulties or problems throughout the group-based research project?

1.7   Research Approach

According to previous CIB and CIS studies, various work tasks and social factors have been shown to influence students' information behavior within their organization. Most of the research has, however, been conducted in limited contexts and settings.

First, while a number of studies have been conducted on collaborative information behavior, the majority of them were in the area of computer-supported collaborative work (CSCW), human-computer interaction, and computer-supported collaborative learning (CSCL), not LIS (Prekop, 2002). Moreover, most of the previous CIB studies in the LIS field have focused mainly on the roles of group members or their perceptions of group work, and not on the behavior associated with group members' information problem solving. Therefore, there is a need for a clearer understanding of collaboration in information seeking behavior, specifically in the field of LIS.

Second, even though several models of CIB have been investigated to explain CIS and information behavior, most of the studies have been analyzed by traditional information behavior models. Since most traditional models have been focused on individual behavior, those results cannot be fully applied to collaborative problem-solving in complex situations.

Third, many researchers have believed that information seeking behavior in learning environments is one of the most important factors affecting students' learning, so they have applied this perspective to the study of CIS in educational contexts. Chung and Neuman (2007) considered that learning is one of the major goals of students' information seeking, so its impact on learning must be reflected in various contexts and different learning tasks. Marchionini (1995) also stated that information seeking is related to learning and problem-solving because the goals of both are to change knowledge. As well, Neuman (2001) emphasized that it is necessary to

8

study students' information seeking with a holistic view of their learning in an information-rich environment. In the context of learning environments, although some studies have been focused on students' information seeking behaviors (e.g., Kuhlthau, 1991, 1993; Limberg, 1999; Dodd, 2007; George et al., 2006), most of these studies have treated student's learning and information seeking as individual activities, not collaborative or group work. Recently, a few studies have been undertaken in the area of CIS focused on educational contexts (e.g., O'Farrell & Bates, 2009; Foster, 2009; Hyldegård, 2006, 2009) and interventions between peers throughout the group research process. However, there is little evidence of qualitative and empirical measures of CIS in learning environments, particularly in higher education.

Therefore, the design of the present study was based on both a traditional information behavior model focused on the individual level and a new CIB model focused on the group level. It investigated how graduate students performed information seeking activities and how they perceived degrees of collaboration and difficulty of the research project by undertaking both quantitative and qualitative approaches. The primary data collection methods were a behavior survey with closed- and open-ended items and content analyses of online communications.

1.8   Summary

Working with others within a group can have various positive effects, and the advantages of collaboration have been discussed in a variety of areas. In LIS, the use of collaborative information seeking in a learning setting is increasing among students.

The purpose of this study was to understand graduate students' collaborative information seeking and use through the process of a group project, what difficulties students experience in each stage of the process and which factors affect the students' experience in collaborative work,

using the frameworks outlined in Yue and He's CIB model, which describes the users'

information behaviors in collaboration and Kuhlthaus' information search process (ISP) model,

which describes the users' overall activities in the process of information seeking.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

       This literature review discusses research that supports the development of the research

questions. This research provides a conceptual background of collaboration and collaborative

information behavior, the level of collaboration, and how the concepts have been studied in the

context of library and information science (LIS). The review also explores previous research

focused on the information seeking process, the models, and empirical studies in individual and

collaborative contexts.

2.2   Conceptual Background

       To understand collaboration in information seeking, it is necessary to review the related

works of collaborative information seeking (CIS) from a broader aspect of a wide variety of

disciplines, such as the general concept of collaboration in management, computer science,

sociology, science, with a focused view on collaboration and information seeking in LIS.

Therefore, this section is a review of studies from previous literature that discuss what

collaboration means in a variety of contexts, the principles of collaboration, and the actual

practice of collaboration in information seeking. This supports the identification of what is

considered in collaboration in information seeking behavior and provides insights into research

trends on collaboration on information seeking behavior.

2.2.1   Definitions of Collaboration

In order to critically research CIS, it is important to have a clear understanding of the concept of collaboration. Collaboration has been studied in a wide variety of disciplines, such as management, computer science, sociology and LIS. Also, it continues to increase in frequency and importance for solving complex scientific problems and understanding various social issues (Sonnenwald, 2007). Therefore, the definition varies with each discipline.

Collaboration focuses on the process of working together. As a philosophy of interaction, collaboration considers an individuals' responsibility for their actions, including learning and respecting the abilities and contributions of their peers (Zhao, Li, & Kanji, 2001). Chrislip and Larson (1994) defined collaboration as a commonly useful relationship between two or more people who work to achieve the same objectives by sharing a task, ability, and responsibility for accomplishing outcomes. Roschelle and Teasley (1995) described the concept as "the result of a continued attempt to construct and maintain a shared conception of a problem" (p. 70). Dillenbourg et al. (1995) also focused on the shared understanding of a problem as the foundation of the group activity, and viewed the main characteristic of this concept as cognitive. In addition, it involves a situation where the collaborating entities share the same information space, awareness, and common and consent strategies (Ntuen, Paul, & Marcos, 2006).

In scientific settings, collaboration has been identified as having two parts, focusing on collaboration within an organization and among individuals (Hara, Solomon, Kim, & Sonnenwald, 2003). In business and management, collaboration is commonly considered from an organizational perspective. Mattessich and Monsey (1992) viewed collaboration as "a mutually beneficial and well-defined relationship entered into by two or more organizations to achieve common goals" (p. 7). Similarly, Kagan (1991) described collaboration as the structures of an

12

organization where information resources, rule and authority are shared. Generally, these definitions characterize collaboration as involving individuals in organizations who are responsible for activities intended to achieve common goals through shared information resources or authority.

Schrage (1995) viewed collaboration as the process of shared conception in which is two or more individuals with interrelated skills interact to build a shared understanding. Iivonen and Sonnenwald (2000) defined collaboration as "human behavior that facilitates the sharing of meaning and completion of activities with respect to a mutually shared super-ordinate goal and which takes place in a particular social, or work, setting" (p. 79). These definitions can be summarized as having two common elements: working together for a joint purpose, and sharing of meaning, resources, knowledge and responsibility (Hara, Solomon, Kim, & Sonnenwald, 2003).

These previous studies have shown that there are a variety of definitions of collaboration that can be broadly characterized as an activity for solving a complex problem or achieving a work task among two or more people. In addition, various factors can be used to attain effective collaboration, such as full integration and communication. For this study, collaboration was defined in accordance with Iivonen and Sonnenwald (2000) as focusing on interactions among individuals for the purpose of sharing meaning, knowledge, or information resources to accomplish common goals and solve complex problems.

2.2.2   Levels and Types of Collaboration

Researchers have explored the levels and the types of collaboration in schools and workplaces to evaluate the process of collaboration. Collaboration can be typically regarded as a

complex process and a dynamic interaction involving several parts, so researchers have

emphasized that assessing collaboration is essential for successful relationships among

organizations or individuals. In LIS, Shah (2008) proposed a model of collaboration consisting

of five levels: collaboration, cooperation, coordination, contribution, and communication (see

Figure 2.1).
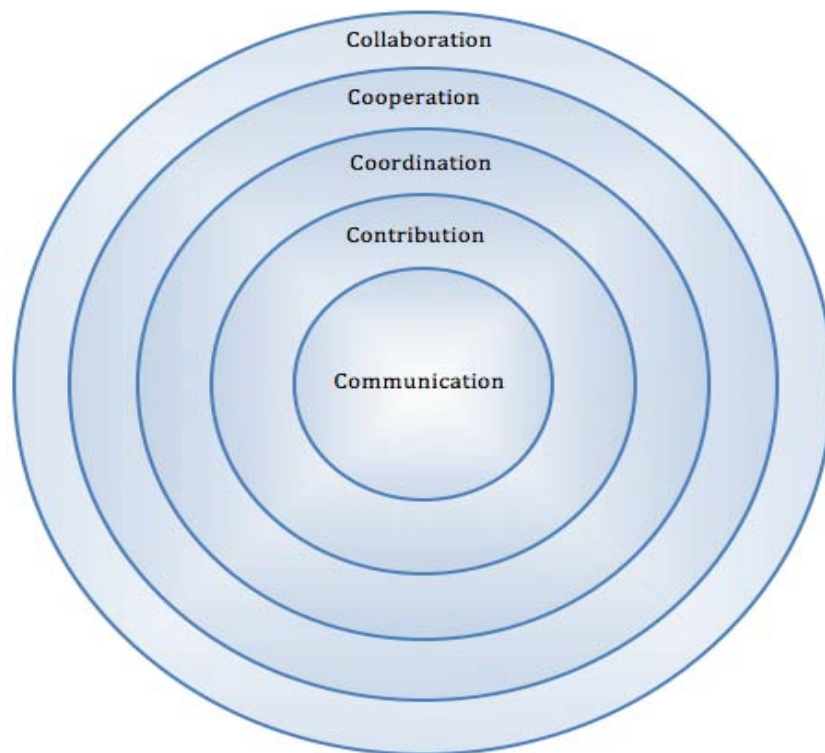
Figure 2.1. Model for collaboration (Shah, 2008, p.1).

The first level of this model is communication, which is one of the core and required

processes for carrying out collaboration. At this level, the process of sending or exchanging

information is generated by people in the community. The second level is contribution, which is

an informal relationship between individuals to help each other for accomplishing their

individual goals. The third level is coordination, which is a process of connecting groups

together for sharing resources and responsibilities for their common goals. The fourth level is

cooperation, which means a relationship between groups with similar objectives that take part in

sharing resources and discussing tasks to accomplish the groups' common goals. Collaboration is

the highest level of this model, a process of involving people who are engaged in different

aspects of a problem. At this level, people can search for and explore information using their

own expertise and knowledge to find their common solution. Thus, collaboration involves

creating a solution.

To measure the stages of collaboration, the School Program Evaluation and Research

Team (Frey, Logmeier, Lee, Tollefson, & Johanning, 2004) proposed the levels of a collaboration

scale based on Hogue (1993) and Borden and Perkins (1999). The collaboration process consists

of five stages, which are 1) networking, 2) cooperation, 3) coordination, 4) coalition, and 5)

collaboration. Detailed descriptions of the five stages are provided in Table 2.1. Given the

definitions of each level, collaboration can be reported as the quantitative scale of perceived

collaboration by collaborating partners. Also, the scales of collaboration can differ depending on

the purpose of collaboration, whether tasks or organizational strategies.

In order to make clear what situations could construct a meaningful and successful

collaboration between people, Horvitz (1999) proposed five major types of collaboration, in

which the collaborating organizations: 1) have a mixed initiative relationship, such as

information seeking, interpretations and solutions to the problem being addressed; 2) have a

shared sense of purpose; 3) must interpret the conditions of the environment in the same way

(shared situation); 4) have shared planning, such as a common set of expectations about the

availability and applicability of methods to resolve the problem; and 5) require a

communications instrument to enable them to exchange information about the cooperative

initiative, joint purpose, situations and problem resolutions.

Table 2.1

Level of Collaboration Scale

Five Levels of Collaboration and Their Characteristics

Networking 1	Cooperation 2	Coordination 3	Coalition 4	Collaboration 5
-Aware of organization	-Provide information to each other	-Share information and resources	-Share ideas	-Members belong to one system
-Loosely defined roles	-Somewhat defined roles	-Defined roles	-Share resources	-Frequent communication is characterized by mutual trust
-Little communication	-Formal communication	-Frequent communication	-Frequent and prioritized communication	
-All decisions are made independently	-All decisions are made independently	-Some shared decision making	-All members have a vote in decision making	-Consensus is reached on all decisions

Note. From Frey et al., 2004, p. 387.

Sonnenwald (1995) also emphasized that the type and frequency of communications

among team members is very important to achieve effective collaboration in the workplace.

Additionally, Surowiecki (2004) stated four significant conditions required for a meaningful

collaboration: 1) diversity of opinion, 2) independence of opinion, 3) decentralization of

knowledge, and 4) aggregation.

2.2.3   Collaboration in the Field of LIS

To understand the concept of collaboration in information seeking behavior, it is necessary to see how it has been studied and presented in the context of LIS. Collaboration is often considered to be a significant factor in scientific research, which is dominated by complex problems, rapidly changing technology, dynamic development of knowledge, different types and levels of information sharing, and highly specialized skills (Hara, Solomon, Kim, & Sonnenwald, 2003; Galison & Hevly, 1992; Talja, 2002; Weinberg, 1961). Scientific collaboration has been a core area of study for many researchers in the field of LIS, because science itself is a collective and collaborative activity. For instance, bibliometric research on previous and current studies of scientific collaboration has been popular in LIS (e.g., Sonnewald, 2007). Other studies have explored scientific collaboration by analyzing scientists' perspectives and attitudes regarding collaboration, types of collaboration, outcomes and processes of scientific work in collaboration, and factors that impact collaboration (e.g., Hara, Solomon, Kim, & Sonnenwald, 2003; Sonnewald, 2003; Kim and Ju, 2008). The results of the studies may build a framework for the pattern and view of scientific collaboration in social and organizational experiences, which are needed to institute collaboration in the field of LIS. Factors and their effects on collaboration are shown in Figure 2.2.

This framework illustrates a variety of types of collaboration between scientists, from complementary collaboration to integrative collaboration. In complementary collaboration, the division of a project occurs. As the type of collaboration shifts to integrative, some kinds of shared projects and integration take place. The authors also identified several factors that influence collaboration, such as compatibility, work connections, incentives, and socio-technical infrastructure (Hara, Solomon, Kim, & Sonnenwald, 2003, p. 963).

Types of Collaboration	Factors			
	Compatibility	Work Connections	Incentives	Socio-Technical Infrastructure
Complementary	Work style Priority ↑ ↓ Management style ↓	Work interests Expertise ↓ ↓	External, e.g., funding & publication ↓ ↓	Awareness Communication mechanisms Organizational culture & structure ↓
Integrative	Approach to science Personality		Internal	Unlimited access to collaborator(s)

Figure 2.2. Factors influencing the different types of collaboration (Hara et al., 2003, p. 959).

As noted, many researchers have emphasized that the activity of information seeking is an important factor in collaboration as a research tool of LIS. It is essential that people seek information together and share common resources in order to do a successful job in complex and scientific tasks. In short, the literature supports the importance of collaboration in information seeking that is the focus of this study.

Before discussing the emergence of the terms "CIS," "collaborative information retrieval" (CIR) or "collaborative information behavior" (CIB), it is appropriate to look at previous studies focused on information seeking. Since the 1970s, there has been a move in the research paradigm from a system-centered approach toward a user-centered approach. The user-centered paradigm in LIS emerged from Dervin and Nilan's (1986) article. Information seeking has traditionally been conceived as a solitary activity: a user identifies an information need, uses some tools to discover useful information, and iteratively satisfies the information need. The user-centered paradigm takes a cognitive approach focused on an individual's knowledge structure and on the information user as a unique individual (e.g., Kuhlthau's emotional aspects in the ISP model is a unique response by an individual). Thus, the cognitive viewpoint is concerned with how an

individual identifies needing, seeking, sharing, and using information (Karen, Santacruz, & Swagerty, 2001). By the end of the 1980s, numerous theoretically grounded studies on the cognitive approach were constructed to identify various patterns in information behavior and to apply them to the development of information retrieval systems (e.g., Ellis, 1989; Cole, 1998; Kuhlthau, 1991; Vakkari, 1999; and Wilson, 1999).

From the early 1990s, many researchers have taken a social approach to studying information behavior. This type of research looks at the effect of interpersonal relationships and the dynamics of information flow. The researchers have increasingly studied how information is shared in human communication. In this sense, unlike the cognitive approach analysis, these types of studies are not focused in terms of an isolated individual, but are based on social, sociocultural and sociolinguistic aspects of information behavior. As a leader in this approach, Chatman (1996, 2000) constructed three frameworks for studying information behavior focus based on social science theory. Beyond Chatman's studies, a number of influential frameworks for information behavior based on social science have been developed in LIS (Karen, Santacruz, & Swagerty, 2001). Scholars undertook various studies to understand the effect of interpersonal relationships and how information sharing is related to human communication (e.g., Tuominen & Savolainen, 1997; Dervin, 1994; Pettigrew, 1999, 2000).

Recognizing the complex nature of human information behavior, many researchers have stressed the importance of conducting research on collaborative information seeking. For example, Sonnenwald (1995, 2000) described information behavior as a collaborative process among individuals and information resources and explored information behavior in a dynamic work context (e.g., command and control). Even though she did not use the term "collaborative information seeking" or "collaborative information behavior," she studied information behavior

in a group work context. Other studies also emphasized the importance between information

behavior and team performance and information exchanges in a group (e.g., Allen, 1977; Kraut

& Streeter, 1995; Sonnenwald & Lievrouw, 1997). Recently, the focus on collaborative

information work has been applied in various information seeking contexts, such as the medical,

education, engineering, and design.

Numerous theories, derived from the results of empirical studies, have been constructed

to describe varying aspects of information behavior, including cognitive, social and other factors.

However, despite a number of studies being conducted on information seeking, there are still

many factors, such as those in collaborative information seeking that warrant further

investigation. Therefore, studies should continue to employ multifaceted approaches to improve

the theoretical frameworks in LIS.

2.3   Collaboration in Information Research: CIS, CIB, and CIR

CIS is the core of this study, so it is necessary to review the definitions of collaboration in

information behavior. According to previous research, most researchers agree that there are a

number of definitions that can be broadly characterized as an activity for solving a complex

problem or achieving a work task with two or more people together. However, the terminology

used by different authors is diverse according to the scope of information behavior (e.g., CIB,

CIS, CIR, and collaborative information sharing). Regarding the scope of investigation on

information behavior, Wilson (1999) indicated that information retrieval is a narrower concept

than information seeking, thus information retrieval can be part of the context of information

seeking practices in information behavior processes. Therefore, he considered information

behavior as the importance of social factors and as broad senses, including acquiring, retrieving,

seeking, managing, sharing and generating information. Also, research in information seeking

includes information retrieval and information use.

Talja and Hansen (2006) described CIB as "processes of problem identification, analysis

of information need, query formulation, retrieval interactions, evaluation, presentation of results,

and applying results to resolve an information problem" (p. 114). CIB includes people's intricate

process of activities to resolve their information needs. They also defined the range of CIB that

results from collaborative sharing, database or Web searching, information sorting,

understanding, and synthesis. They considered CIB as peoples multiple and extensive

information activity. Another definition of CIB was explained by Poltrock, Dumais, Fidel, Bruce,

and Pejtersen (2003) as "activities that a group or team of people undertakes to identify and

resolve a shared information need" (p. 239). They emphasized that the definition of CIB has two

important concepts. The first concept is "collaboration," which is people working together to

seek information. The second concept is "resolving an information need," which includes

seeking, retrieving, and using information to solve a problem (p. 239). Thus, they considered CIS

to be a broad concept that involves the whole range of information activities from identifying

information needs, formulating search terms, seeking information, and using the found

information to solve their problem in collaboration.

Among the collaboration in dynamic information activities, Bruce, Fidel, Pejtersen,

Dumais, and Grudin (2003) explained that information seeking activity is a fundamental aspect

of collaborative work to attain effective achievement in organizations. CIS has been

conceptualized as "the study of systems and practices that enable individuals to collaborate

during the seeking, searching, and retrieval of information" (Foster, 2006, p. 330). Another

definition of CIS by Hanson and Jarvelin (2005) calls it "an information access activity related to

a specific problem solving activity that, implicitly or explicitly, involves human beings interacting with other human(s) directly and/or through texts as information sources in a work task related to information seeking and retrieval process either in a specific workplace setting or in a more open community or environment" (p. 1102). Also, they classified the types of collaboration related to the activities of information seeking and retrieval: sharing the common need for information; sharing search strategies; sharing search results; sharing retrieved information objects; interpretation and creation of the retrieved information entities, and creating useful information for group knowledge (p. 1103). In general, most studies of CIS have typically focused on how people seek, search and retrieve information collaboratively, or on how people work together to understand the different portions of information by sharing during CIS behavior.

Otherwise, Hertzum (2008) conceptualized CIS as a combination of information sharing and collaborative grounding, and emphasized by the central role of information sharing in CIS. Also, he defined CIS as "activities performed by actors to inform their collaborative work combined with the collaborative-grounding activities" (p. 958). Further, Paul and Reddy (2010) added the meaning of the term CIS as a simple activity, including not only collaborative information seeking but also sharing, understanding, and using information in collaboration.

As previously noted, there are various meanings of collaboration in the activities of information seeking and retrieval in LIS studies. In many cases, the term "CIS" is used interchangeably with terms such as CIB and CIR. For example, Poltrock, Dumais, Fidel, Bruce, and Pejtersen (2003) stressed a "shared information need"; Hansen and Jarvelin (2005) emphasized the process of information retrieval on collaboration as an "information access activity related to a specific problem solving activity." In addition, Hertzum (2008) defined CIS as "a combined activity with the information seeking activities and collaborative grounding."

22

Thus, even though many researchers have posited definitions of CIS, there is no universally accepted characterization of the concept.

By following Paul and Reddy's ideas, information seeking behavior is not limited to information activities only, but can also be covered by a broader set of activities such as searching, sharing, and using. Therefore, CIS can be explained as an important practice composed of various and complex activities, including information seeking, searching, and using their understanding and solving a common problem. This study follows their ideas by exploring how people seek, share, and use information in collaborative settings.

2.3.1   Traditional Models of Information Behavior

Researchers have created information seeking models to explain a strategy to predict activities by individuals to find information (Case, 2002). Wilson (1999) characterized information behavior as the activities which are generally used by a person to determine his or her need for information, searching for the information to meet his or her need, and using or sharing the information. Pettigrew, Fidel, and Bruce (2001) also defined information behavior as "how people need, seek, give, and use information in different contexts" (p. 44). In this sense, research on information behavior has generally been adapted to the field of LIS, and many researchers have proposed a number of influential models and theories of information behavior. Among them, this section focuses on four major traditional models of informationseeking behavior which are oriented to a user-centered approach to information seeking: Dervin's (1983) sense-making theory; Ellis (1989); Kuhlthau's (1991) information search process model; and Wilson's model in 1996. Wilson (1999) defines the models of information behavior as "statements, often in the form of diagrams that attempt to describe an information–seeking

23

activity, the causes and consequence of that activity, or the relationships among stages in information seeking behavior" (p. 250). Also, he stated that these models can be the essential theoretical framework and basis for research problems of human information seeking behavior.

Dervin's (1983, 1992) sense-making model has been perceived as a theoretical perspective and a set of assumptions rather than a model of information seeking behavior in the area of information behavior. The model is composed of four integral factors: a situation, which is the context in which information needs come up; a gap, which defines uncertainty and confusion; an outcome, which identifies the result from the sense-making procedure, and a bridge, which means the gap between the factors of the situation and outcome (Dervin, 1992, p. 66). Wilson (1999) said the sense-making model explains how an individual makes sense of his/her situation, solves a problem by his/her information seeking and using, and bridges the gap between the situation and the result. Thus, in this model, a person's information seeking is considered as a dynamic information process through its four elements: a situation, a gap, an outcome, and a bridge (p. 253). Dervin's model is focused on a single user's information activity, but it also can be applied to purposes of "collectives" in information seeking behavior. However, she did not provide a detailed explanation of the term "collective" and how the model can be related to cooperative information activities (Reddy & Jansen, 2008). In describing Dervin's model of information seeking, Wilson (1999) pointed out that the strong point of this model is its various methodological applications into the research of information behavior. Thus, he considered the model as a methodological paradigm, rather than a model for a series of information behaviors. Thus, the model can show problematic situations, the gap of uncertainty, and outcomes from information use in relation to information seeking activity through its four essential elements.

As a user-centered approach, Ellis (1989) developed a behavioral model of information seeking to identify an individual's various patterns in information seeking behavior within the system. It is based on empirical research in the context of social and physical sciences and consists of eight features of different behaviors in information seeking: starting, chaining, browsing, differentiating, monitoring, extracting, verifying, and ending. Ellis stated that "the detailed interrelation or interaction of the features in any individual information seeking pattern will depend on the unique circumstances of the information seeking activities of the person concerned at that particular point in time" (1989, p. 178). Thus, this model aims to describe the different behavior patterns of information seeking across a variety of situations and context. However, this model only describes a user's different sequences in the overall search process, rather than different combinations of features or arrangements. Therefore, it does not capture a user's real information seeking process.

Kuhlthau (1991, 1993) proposed a model of the individual information search process related to a user's feeling, thoughts, actions and information tasks. She stated that most research in human information behavior has concentrated on the information seeker as a single user and on the relationship between a user and information systems or social circumstances. With this view, her model is focused on an individual's information search process and is divided into six stages: 1) initiation, 2) selection, 3) exploration, 4) formulation, 5) collection, and 6) presentation; and the activities of the model are: 1) recognize, 2) identify/formulate 3) gather, and 4) complete. Kuhlthau's model added the stages and the activities of the information search process to Ellis' model and the process is related to feelings, thoughts, actions, strategies and moods based on the various information behaviors (Wilson, 1999). Thus, this model presented the stages of information seeking behavior, feeling, and thought based on a series of research on high school

25

students' class projects (see Figure 2.3). In her model, the "uncertainty principle" stage has been

emphasized as a fundamental proposition in information seeking behavior. She said that the

feelings of uncertainty are mainly due to a lack of understanding, a gap in meaning and a limited

construct. The feelings of uncertainty arouse the feelings of confusion or doubt, and the situation

initiates the process of information seeking to resolve the problem (1991, p. 23). Hence, in

Kuhlthau's model, the importance of cognitive and affective components is emphasized in each

different stage of information behavior.

Model of the Information Search Process							
	Initiation	Selection	Exploration	Formulation	Collection	Presentation	Assessment
Feelings (Affective)	Uncertainty	Optimism	Confusion Frustration Doubt	Clarity	Sense of direction / Confidence	Satisfaction or Disappointment	Sense of accomplish-ment
Thoughts (Cognitive)	vague		→	focused	increased	interest	Increased self-awareness
Actions (Physical)	seeking	relevant Exploring	information	seeking	pertinent Documenting	information	

Figure 2.3. Kuhlthau's ISP model (Kuhlthau, 2004, p.82).

Kuhlthau and her colleagues conducted further research to generalize the model of

information search process (ISP) based on the constructivist approach to learning (Kuhlthau,

Maniotes, & Caspari, 2007). In her model, it reflects the nature of learning as a process of

seeking meaning and knowledge construction. This model is grounded in a series of user studies

of information seeking patterns from high school and college students' learning activities. The

studies have been undertaken to explain the research process as a learning practice experienced

by students. Based on her own ISP model, she suggested a *zone of intervention* which corresponds with levels of the information search process and presented various intervention strategies to use in the information search process in a learning environment (Kuhlthau, 1993). She defined a zone of intervention as "that area in which an information user can do with advice and assistance what he or she cannot do alone or can do only with great difficulty" (2004, p. 129). In a series of intervention strategies, she provided the acts of a librarian or a peer as a collaborator to help students' difficulties or problems in the information search process. Through interventions between peers, they can minimize the problems and accomplish their information task successfully.

Later, an impressive number of studies based on the ISP model were conducted in various contexts, especially in undergraduate and graduate settings. The research included students' learning tasks (e.g., Cole, 1997, 1998; Fister, 1992; Holliday & Li, 2004; Kennedy, Cole, & Carter, 1999; Pennanen & Vakkari, 2003; Serola & Vakkari, 2005; Swain, 1996; Vakkari, Pennanen, & Serola, 2003; Valentine, 1993; Yang, 1997), LIS (Isbell & Kammerlocher, 1998), anxiety and students' perceptions of research (Kracker, 2002), and changes in students' effect on a research assignment (Vidmar, 1998). Other research has been done to understand online classrooms (Byron & Young, 2000), and collaborative search tasks (Hyldegård, 2006, 2009; Hyldegård & Ingwersen, 2007; Shah & Gonzalez-Ibanez, 2010). The findings of these studies verified that the ISP model has applicability in higher education by investigating college students' information behaviors, feelings, and thoughts. Further, they validated and supported the utility of the model in various dimensions, such as education, and public and school libraries.

Wilson developed a model of information seeking behavior based on his model in 1981, which is based on research in psychology, health communication, and decision making. In this

new model, although the terms are changed, he maintained some of the basic framework of his earlier model, such as the context of information needs, the intervening variables, and information–seeking behavior. In addition, he added other theoretical models of behavior such as "stress/coping theory," "risk/ reward theory," and "social learning theory" that makes the new model more powerful for further research and hypotheses than his original model (p. 256). His model aims to describe how information needs arise and what may frustrate a person's information search. The model explains a simplified way the relationships between the theoretical ideas and processes of information behavior and cognition connected with the user's information needs (Wilson, 1999). In this model, Wilson assumed two propositions: first, information needs are secondary needs by the context, which can be the person, his/her role in work or life, or the environments; and second, the contexts determine the awareness of information barriers, and the ways in which a need is satisfied (p. 257). Thus, he considered information seeking as a problem solving activity driven by the call for reducing uncertainty. As Sonnerwald and Pierce (2000) noted, the model can be applied to users from various backgrounds, since it was developed from research in various fields, such as communication, health information and economics. However, although cognitive, affective, and physical behaviors are important in the information seeking process, Wilson's model does not consider those aspects in the process (Bilal, 2002).

As discussed above, the traditional models of information behavior have focused on individual user's behaviors in information seeking and usage as a consequence of his or her information needs using information sources or services. As the interest of research has shifted to focusing on how people work together to find information for a common goal, we call for a clearer understanding of people's collaborative information behavior (Fidel et al., 2000). Thus,

there is still a lack of studies and frameworks to understand collaborative information activities, especially in LIS. Since CIB cannot be fully explained by the earlier models of individual information seeking, a review is needed on the existing studies and analysis on the more theoretical research grounded by empirical studies in various circumstances.

2.3.2   Models of CIB

As researchers created several information seeking process models, collaborative information behavior models were also developed by researchers to describe individuals' or organizations' information behaviors in collaboration. Each model presents a description of the steps or activities engaged in collaborative information behavior.

Prekop (2002) conducted a qualitative study to understand the collaborative information seeking activities in the command and control domain. Reddy and Spence (2008) stated that Prekop's study was an initial information seeking model from the perspective of collaborative activities. Prekop pointed out that the earlier models of information behavior focused on the personal process aspect, so he presented a qualitative study of information behavior from the aspect of group process (p. 533). By collecting data from the working group's meetings and conducting semi-structured interviews, he identified three important components for the activity of collaborative information seeking: 1) information seeking roles; 2) information seeking patterns; and, 3) the context in which the roles and patterns were performed (p. 536). The relationship between the three factors of collaborative information seeking behavior is shown in Figure 2.4.
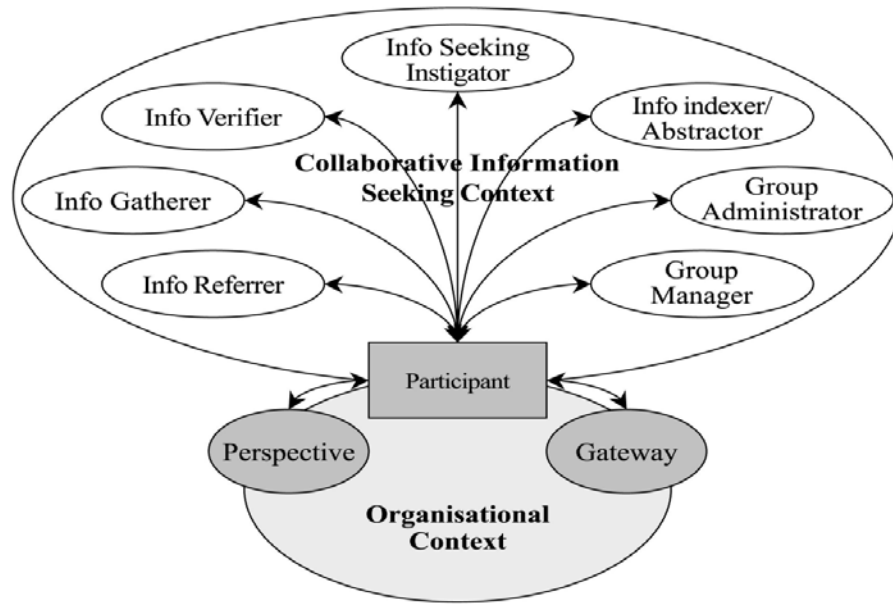
Figure 2.4. Model of collaborative information seeking (Prekop, 2002, p. 526).

First, he categorized the following information seeking roles that describe students'

activities and responsibilities within the working group: 1) information gatherer; 2) information

referrer; 3) information verifier; 4) information seeking instigator; 5) information

indexer/abstracter; 6) group administrator; and, 7) group manager. The group members in

organizations performed multiple roles in the collaborative information seeking activities

according to the group's rules or structures. Also, the roles were formally assigned or informally

accepted through explicit and implicit mediation (Prekop, 2002, p. 538-543).

Second, he identified two contexts from the study. The collaborative information seeking

context includes what is collectively known as well as the history of the working group, its

norms, social rules and social structure (p. 536). He stated that the practices of collaborative

information seeking and the group members' various collaborative information seeking roles are

performed within this context. Another context is organizational, which explains each group

members' characteristics within the organization. All group members have their own specialist information seeking roles, perspectives and gateways (p. 537).

The third component of the collaborative information seeking behavior is the patterns of information seeking activities between the roles within the contexts, including "information seeking by recommendation," "direct questioning," and "advertising information paths," which are strongly connected to the information behaviors and interactions performed by students playing any of the various roles within the group. In particular, the pattern of information seeking by recommendation is related to the information referrer's role and user's collaboration with information instigators and information gatherers. Also, when information was asked for and transferred, the pattern of direct questioning was the natural option. Additionally, the pattern of advertising information paths was related to presenting possible methods by which to seek information, including information gatherers and information indexers/abstracters (p. 543-545).

This model provides a means of describing many different roles, contexts and patterns of collaborative information seeking, which should be identified for interaction between information behavior and systems or tools for collaboration. For verifying the descriptive model, this can be applied to a variety of contexts of the activities of collaboration information seeking. However, it does not provide information on what users are actually doing in collaboration, and how their behaviors are changed in collaborative information seeking at different times and stages.

Karunakaran, Spence, and Reddy (2010) framed an overview of the CIB research and developed a model of the CIB based on a review of the previous studies (see Figure 2.5).
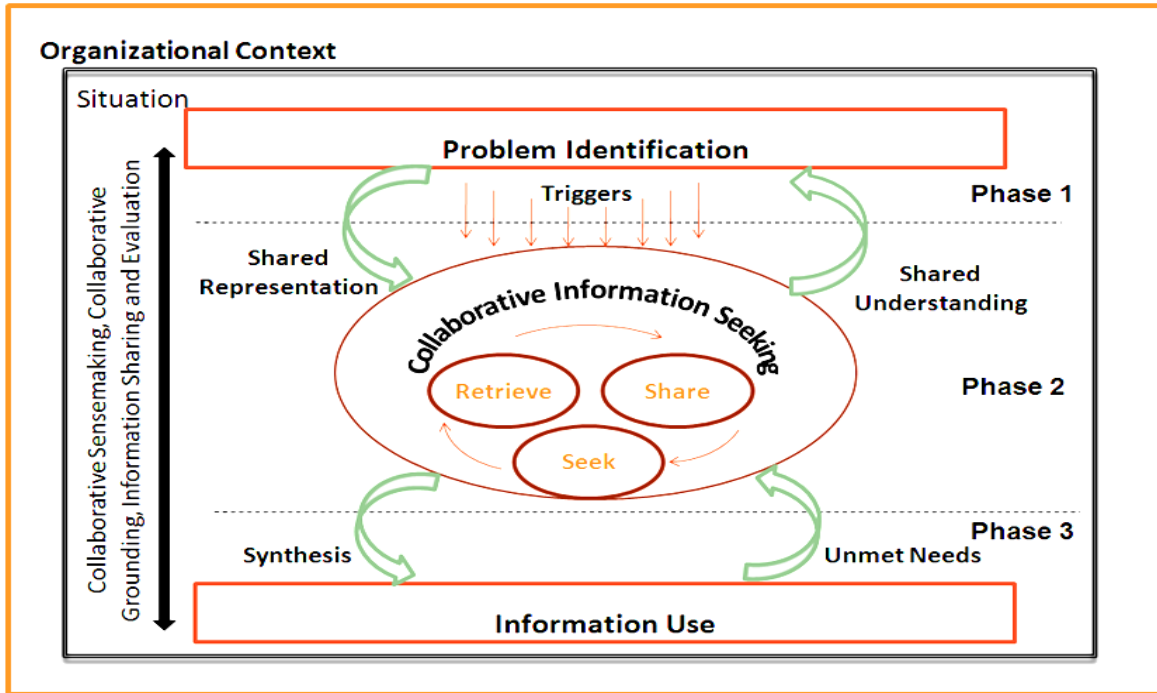
Figure 2.5. A model of CIB (Spence & Reddy, 2010, p. 3).

They have conceptualized the CIB research into two major streams, social and technical. The social stream includes problem identification and collaborative sense-making, collaborative information seeking, searching, retrieval and use. Some studies in the technical stream include collaborative information seeking, searching, retrieval, collaborative web search and querying, and filtering. In their study, the authors emphasized that CIB and individual information behavior (IIB) have different approaches for each activity, so they developed a conceptual model based on the aspects of CIB within the organizational context. In this model, they explained the three phases of group-based information activities and emphasized situational elements and contextual triggers (p. 266).

In the model, the first phase of CIB is the process of problem identification. In an organization, people generally sort out problems or needs and produce a shared representation of

the problems to solve them through communication. In this study, they found that there are major triggers for shifting from individual information seeking activities to CIB: lack of domain capability, complexity of the information need, and fragmented information resources with a lack of immediately accessible information. Thus, when people have complex triggers to resolve information problems, this initiates the transition from individual information behavior and many of the group activities (p. 267). At the second stage of activity, people's collaborative information seeking behavior is generated to solve the complex problem and to satisfy the shared goal. The researchers emphasized that CIS is a composite of three micro levels including seeking, retrieving and sharing (p. 267).

At the second stage of activity, people's collaborative information seeking behavior is generated to solve the complex problem and to satisfy the shared goal. The researchers emphasized that CIS is a composite of three micro levels including seeking, retrieving and sharing (p. 267).

In the last stage, the information obtained in the first two stages is also collaboratively compared and evaluated for common understanding and use. The information includes physical, mental, and communicative behaviors based on the group's existing knowledge. In addition, throughout the entire procedure, the activities of collaborative information sharing, grounding, and sense-making continuously occur across all phases (p. 267-8). This model presents the steps of information seeking behavior, situational elements and contextual triggers based on the authors' research. Thus, it describes the collaborative information seeking process as a dynamic activity to solve the common problems or goals. However, this model needs testing and refining by more empirical examination in various contexts for verification of the model.

Based on a review of previous experiments of information seeking centered on

information access and organization, Shah (2008) presented a model for CIS which has been

extended from the general model of information seeking (see Figure 2.6).
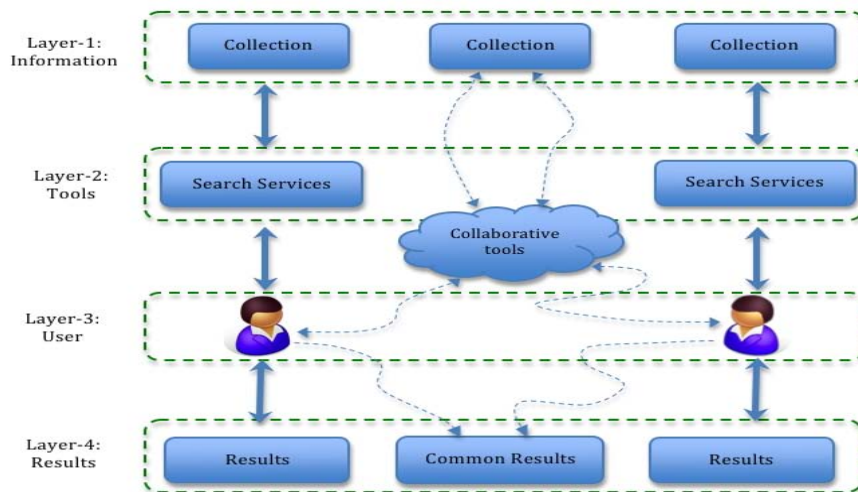
Figure 2.6. Model for CIS (Shah, 2008, p. 4).

The model consists of four layers: 1) information: contains information in various sources

and formats, including digital libraries, wikis, databases, and formats include text, images, and

videos; 2) tools: consists of tools and techniques to access the information, including search

services, relevant feedback, and query term suggestions; 3) user: users, who use the tools and

techniques to access the information; and 4) results: the knowledge and information that the

users collect via their information seeking process to resolve their problem. To be specific to the

CIS model, the author described various situations in which a group of users collaborate using

several tools to accomplish their personal or common information goals. For example,

collaboration between two or more users can take place at various stages: 1) while putting

together an information demand, 2) while gathering results, and 3) while organizing and using

the results to solve a problem.

Shah proposed this model based only on previous studies and notions in the context of

collaboration information seeking. He stated that this model could help in evaluating existing information collaboration systems and could be applied to different CIS environments. However, for this model to be more specific, researchers should investigate empirical studies in which various groups of users have many kinds of collaborative tasks in order to accomplish personal or common information needs and goals.

Based on an experience with CIB in e-discovery tasks in TREC 2009, Yue and He (2010) proposed the following model, shown in Figure 2.7. The model explains that there are different stages in CIB and different collaboration levels such as coordination, communication, cooperation and contribution exist in different stages. Also, various types of collaboration (e.g., synchronous and asynchronous) and supports needed were recognized during the whole process. They concluded that factors such as task difficulty and cognitive load affected students' transitions of collaboration levels, types of supports needed, and collaboration type are apparent in each of the stages.

As presented in the model, at the initial stages of CIS, the main goal of the group is to search the dataset and frame search strategies, and these processes encourage more coordination and cooperation between workers. The users usually begin the search task with an intensive level of collaboration to meet their common understanding of the information need and search strategies. On this level, synchronous collaboration is required from users for maintaining awareness of time. However, in the exploratory stages of information seeking when users have already set up search strategies and decided to search different paths independently, they employ more types of communication and make more contributions as they take on more responsibility. At this stage, users realize their information needs, find information and make judgments by themselves, and rely more often on asynchronous collaboration. In this stage, users can

contribute and accept collaboration support like recommendations and supports for relevance judgments. In the final stages, users are aware that they have achieved a certain point of completion on information searching, and become more involved in collaboration and synchronous collaboration support to combine the found results and to solve the information problem.

Stages	Initial & Exploring ------> Division of labor ------> ...... --------->Final result		
Cognitive Load	---> adaption to the system -----------------------> getting familiar with other collaborators		
Collaboration Levels	Collaborative ----------------> Individual ------------------> Collaborative Coordination Communication Cooperation Contribution		
Collaboration Type	Synchronous --------------------> Asynchronous --------------------> Synchronous		
Subtask complexity	Easy --------------------------------> Difficult ----------------------------> Easy		
Types of supports needed	Support for frequent communication and keeping awareness	Implicit collaborative support (recommendation); Support for relevancy judgment (topic authority)	Shared space for common results

Figure.2.7. Yue and He's model of collaboration (Yue & He, 2010, p. 4).

In a collaborative environment, there is the extra cognitive load on the collaborator compared to individual information seeking, such as adaption to the system (i.e., search tools and collaborative tools) and getting familiar with other collaborators (i.e., gaining trust and making contributions to each other). Therefore, users may need to consider these factors to successfully collaborate during the whole process.

All models discussed here present information seekers' different activities or stages in collaboration. According to many CIB researchers, most information seeking models focus on

the individual user's information behavior and a user-IR system interaction. For example, Reddy and Jansen (2008) pointed out that most studies on information behavior have focused on individual information behavior and paid no attention to collaboration in information seeking. Also, Fidel et al. (2000) claimed that research on individual information behavior has ignored the nature of information behavior in team and collaborative tasks. There are few models on collaborative information behavior and there is still a lack of conclusive evidence because these models have not yet been tested and verified by various empirical studies. Also, they insufficiently explain various information activities and stages of collaboration, because those are not considered different dimensions or characteristic of tasks in a general sense. In addition, although the individual models of information seeking behavior can represent each individual's problem solving in collaboration that may help to understand each individual in the group, more detailed and extended models are needed that characterize collaborative aspects of information seeking behavior for the overall understanding of the activities of CIB.

According to Vakkari (1999), a conceptual model presents an approach of study, a method, and major perceptions and their interrelations, and it can help guide researchers in seeking detailed answers to research questions. As he noted, the above models support the view that collaboration information users reveal general patterns of information behaviors at different stages or situations of the information behavior in collaboration, especially in the models of Karunakaran, Spence and Reddy; Shah; and Yue and He. Table 2.2 indicates the contexts in which the researchers developed their models and the perspectives they pursued.

Table 2.2

Models of the Collaborative Information Process

Model	Context	Perspective
Prekop's (2002) collaborative information seeking model	Users in command and control domain (military)	Contexts of collaborative information seeking and organizational behaviors
Karunakaran, Spence, and Reddy's (2010) CIB model	General users in collaboration	Collaborative information seeking, sharing and grounding
Shah's (2008) CIS model	General users in collaboration	Activities in collaborative information seeking
Yue and He's (2010) collaboration model	Users on e-discovery tasks in TREC	Cognitive and affective behaviors, and level and type of collaboration in search tasks

Although some scholars have defined collaborative information behavior to include the activities of information seeking and use based on empirical studies, scholars overall have given little effort to exploring the relationships between levels, types, or affective elements of collaboration and collaborative information behaviors. Thus, future studies in collaborative information behavior should be focused on developing and verifying the conceptual models in order to understand various patterns of information seeking behavior in collaboration.

From this overview, it can be concluded that most previous models have focused on an individual's behavior, which has not fully complied with the group's information behavior of complex problem solving. Besides, few studies in CIB are even intended to be theoretical frameworks. Therefore, this study explores the relationship between levels, types, and affective factors of collaboration and collaborative information behaviors as a step toward developing theoretical frameworks for understanding foundations of information behavior on collaboration.

2.3.3   Previous Studies of CIB in Various Contexts

In previous research in organizations, some researchers have observed collaborative information seeking activity in settings that include design, education, engineering, military command and control, and medicine. The researchers classified participants as information seekers in collaboration and as information users by their experience with information systems. Although there are few studies in this area, the studies in different contexts have contributed to research on CIB in LIS.

In Karamuftuoglu's (1998) article, he set a conceptual foundation of "social informatics," which is based on research of the relationships between engineers' IR processes. He reviewed a theoretical framework for understanding the collaboration in information seeking. In this study, the author's major point of view is that information seeking is a creative and inventive activity, which is constructing new knowledge and finding extant information (p. 1071). He also emphasized the significance of collaborative IR systems in information behavior; however, most IR systems have focused on the individual because many researchers have viewed IR as an activity from an individual seeker using a database system. Therefore, he asserted that research of IR should be based on teamwork between single users that may help to get more new information and skills from each other's retrieving. Ultimately, the author believed the collaborative activity may facilitate more creative tasks and solve complex problems.

In an early study, Allen (1977) examined the differences in information seeking behavior between engineers and scientists. Allen presented the important characteristics of information seeking-behavior in collaboration, which is engineers' and scientists' personal communications, and a gatekeeper's essential tasks in group works. The gatekeeper or leader has the responsibility to search for information and provide it to members in the team or organization. Also, the other

team members and the leader cooperate with each other to work together effectively in the teamwork. In this environment, the cooperation was enacted through communication between the team members. Thus, the author emphasized that the process of collaboration in information behavior is very useful to the work in the group task. From this study, the author identified the differences in the two groups' information seeking activities (i.e., the roles of group leader and the importance of communications between group members).

Another study of collaborative information seeking and retrieval processes performed in engineering teams was conducted by Hansen and Jarvelin (2005). In order to collect data, they used multiple methods such as semi-structured and open-ended interviews, electronic diaries and observation. They found that collaborative information seeking activities happened throughout the specific process of their work task. They categorized two types of CIR activities: "document-based behavior" and "human-related behavior and communication." The results revealed that the participants were individually involved in collaboration for sharing each other's expertise and knowledge in the process of evaluation of retrieved results. They also found that workers' awareness of each other played an important role in accomplishing successful CIR activities. In particular, this was important for communities, since each member has a variety of different skills and knowledge. Thus, the accomplishment of a group task was affected by each individual's expertise or skills. Therefore, it was important to cooperate with the right persons in the group for successful evaluating and sharing of IR results.

Sonnenwald and Pierce (2000) conducted a qualitative study exploring information behavior in a command and control military setting. They explored how military team members maintained awareness of each other's information seeking activities and how this awareness influenced their information sharing on a work task. Also, they wanted to understand

information-intensive organizations and dynamic situations using various data collection

methods, including document analysis, observation and interviews. The authors identified the

concepts of "interwoven situation awareness," "dense social networks," and "contested

collaboration" as the main factors in military command and control (p. 476). Thus, they

considered human information seeking as a dynamic activity stressed by collaborative

information behavior in which "individuals must work together to seek, synthesize and

disseminate information" (p. 462).

In an educational setting, Hyldegård (2006, 2009) examined how Kuhlthau's information

search process (ISP) model related to CIB in students' group-based learning. She explored how

members of a group perform differently from the individuals represented in the ISP model. She

found that the contextual and social aspects, such as the work task and socio-psychological

intragroup issues, strongly affected group members' physical, cognitive, and emotional

experiences during a group-based project. However, the group's work tasks were experienced

through both individual information seeking activities and through the activities of the work task.

Thus, although social and collaborative factors affected the group members' cognitive and

affective understandings, group members still worked individually. In her later study (2009), she

explored Kuhlthau's ISP model in the context of group-based educational settings and found that,

although there were some similarities between team and individual behaviors in information

seeking, there were also differences in aspects of contextual and social factors. Also, there were

cognitive and affective differences between individual and collaborative information seeking

behaviors. Thus, the author concluded that the social dimension of collaborative information

seeking and the affective and cognitive states of individuals in groups did not completely

coincide with the stages of the ISP model.

To understand interaction in task-based collaborative information seeking and use by undergraduate students, Foster (2009) examined the organization, functions, and forms of dialogic talk that occur, including reviewing, interpreting, and synthesizing information sought and retrieved. The results showed that effective collaboration on the learning task was accomplished by varying levels of main discourse functions, such as users' structuring, informing, eliciting, and summarizing. Also, exploratory, coordinating, dispositional, and cumulative forms of talks occurred during students' collaborative information behaviors. Further, there were variations in the use of the discourse functions and forms of talk across the stages of the task and across the frequency of a groups' discussion. In the context of collaborative information behavior in LIS, the author stated that students are often given a learning task intended to encourage them to seek, assess, and use information in collaboration. In the learning activities, the students are identifying and negotiating their information needs, developing search strategies, and sharing, assessing, and using the information they have retrieved to complete the task. As well, there are various social factors, such as students' discussion skills and the use of technology that can influence their searching, sharing and using information in collaboration.

O'Farrell and Bates (2009) explored students' information seeking and sharing behaviors in course-related group tasks. In particular, they investigated how students communicated with group members during their projects, how they shared information sources, and what they liked or disliked about the group projects. A total of 50 graduate and undergraduate students in the university college Dublin school of information and library studies participated in this study. Data were collected through an online survey, which consisted of both closed- and open-ended items relating to the topic of the project, group communication, use of information sources, sharing of information sources, demographic items, etc.

About 36% of respondents reported being in a group of six students, and the next largest proportion (about 28%) reported four members. About 22% of respondents reported having met four times. The group comprised of undergraduate students only and mixed groups mainly reported meeting less than four times. The majority of students reported using text messaging, email, face-to-face contact, and mobile phones for communication. Most of the students expressed positive perceptions of group projects and thought that they had developed useful teamwork and information sharing skills in their group tasks.

Regarding types of information resources, 95% of respondents indicated that the most shared resources were web sites. Also, they indicated that journal articles, textbooks, and journal titles were commonly shared as information resources. In general, they indicated that electronic sources, such as web sites, Google, and e-journals were more useful than print sources. Also, many students reported that most group discussions were about what information should be used for their project.

Recently, Shah and Gonzalez-Ibanez (2010) explored the information seeking process in collaborative search tasks based on Kuhthau's ISP model. In a laboratory study based on CIS, the authors investigated how the ISP model was different from, and similar to, collaborative information seeking, along with effective relevance, by analyzing users' various actions and conversations. They found that some stages, such as Exploration, Formulation, and Collection in the ISP model, was not distinct in CIS, and that there were repetitive patterns of information behaviors by the participants in their CIS processes. They concluded that the ISP model is a reasonable model for exploring various information seeking behaviors not only by individuals, but also for collaborative search tasks. However, the ISP model needs to be considered in the social dimension and the aspects of effective elements as well as a group's effective relevance in

a CIS setting.

Talja (2002) studied scholars' information seeking and sharing practices, focusing on scholars' use of electronic resources in joint projects, and developed a conceptual framework to explain types of information sharing in academic settings. Four disciplines were chosen as the objects of study: nursing science, history, literature and cultural studies, and ecological environmental science. A total of 44 interviewees from four departments of two universities participated: research leaders, researchers, and doctoral students. She identified four types of information sharing in relation to document retrieval in academic settings: 1) strategic sharing: information sharing as a conscious strategy of maximizing efficiency in a research group; 2) paradigmatic sharing: information sharing as a means of establishing a new and distinguishable research approach or area within a discipline or across disciplines; 3) directive sharing: information sharing between teachers and students; and social sharing: information sharing as a relationship and community building activity (p. 149). She also found that scholars' information behavior was affected by various social networks in which they were involved, and those scholars' social networks are places where information is sought, interpreted, used and created (p. 155).

Studying the collaborative information seeking and sharing aspects of a design team, Poltrock, Dumais, Fidel, Bruce, and Pejtersen (2003) looked at collaborative information seeking from the perspective of information retrieval, involving activities that identify an information need, formulate a query, retrieve information, assess it, and use it to address the needs of a group or team. Thus, they placed collaborative information seeking within the wider activities of the group process, including not only information seeking but also communicating about the information need, sharing the retrieved information, and coordinating the search processes with

people on the team. They viewed a design team as a social entity and examined how the members of two design teams achieve information seeking and sharing collaboratively. They found that, even though the teams had very different products, they exhibited similar collaborative information strategies for attaining information and solving problems: 1) identifying needs collaboratively; 2) formulating queries collaboratively; 3) collaboratively retrieving information; 4) communicating about information needs and sharing found information; and 5) coordinating processes of information retrieval.

In the medical field, Fidel et al. (2000) explored how people on patient care teams seek and use information collaboratively in their IR systems. The authors defined collaborative information retrieval as "any event in which actors collaborated to resolve an information problem that required them to use resources external to their own knowledge" (p. 242). They found that teams in the medical domain were composed of a number of organizational settings according to their tasks and that these teams were highly multidisciplinary, consisting of physicians, nurses, pharmacists, physical therapists, and other healthcare workers. Therefore, team members had different backgrounds and expertise. Thus, although each team member may have had different concerns, work, and motivations, they had to collaborate and coordinate their activities to provide effective patient care. For the main factors of collaborative work, the authors emphasized communication between team members. When communicating in a situation of collaborative work, people could more effectively cooperate and share information from the search.

2.3.4   Methodology in Previous Studies

A number of studies in CIS have been based on both qualitative and quantitative research

methods: an electronic diary, a semi-structured interview and a questionnaire to collect data. Also, most of the studies used meta-analysis methods to obtain an accurate understanding of various information behaviors, as shown in Table 2.3.

Table 2.3

Summary of Selected Studies' Methodology

Researcher	Data Collection Method	Setting
Allen (1977)	Observations and interviews	Engineers and scientists
Hansen and Jarvelin (2005)	Semi-structured, open-ended interviews, diaries, and observations	Engineering team
Shah and Gonzalez-lbanez (2010)	Questionnaire	Education (Laboratory)
Sonnenwald and Pierce (2000)	Observations and interviews	Military
Hyldegård (2006 , 2009), Hyldegård, and Ingwersen (2007)	Observations, diaries, questionnaire, and interviews	Education
Foster (2009)	Experimental: search tasks and group discussions	Education
Poltrock, Dumais, Fidel, Bruce, and Pejtersen (2003)	Observations and interviews	Design team
Fidel et al. (2000)	Observations and interviews	Medical (Patient care team)
Reddy and Jansen (2008)	Observations and interviews	Health care team
O'Farrell and Bates (2009)	Questionnaire	Education

Previous studies in CIS combined qualitative methods to gain integrated findings from participant observations and interviews (e.g. Allen, 1977; Sonnenwald & Pierce, 2000; Hansen & Jarvelin, 2005; Hyldegård, 2006; Talja and Hansen, 2006; Prekop, 2002; Reddy & Jansen, 2008; Reddy & Spence, 2008). The researchers applied multiple methods to explored how participants

worked and acted together effectively in their groups. In particular, Hansen and Jarvelin (2005) used four research methods: semi-structured and open-ended interviews, electronic diaries, and observation to explore collaborative information seeking behavior in a team of engineers.

Reddy and Jansen (2008) observed that the strength of combining methods for studying information behavior by groups is very useful for verifying the processes of obtaining validity and for obtaining data from participants. They emphasized that it is difficult to capture all behaviors and information and explained what they actually achieve in observation with a single method. Many other researchers have acknowledged that using multiple methods results in more valuable studies in social research (Reddy & Jansen, 2008).

Recently, diaries have been used more in studies of information behavior (Hyldegård, 2006). This research tool has been applied frequently to obtain data on collaborative informant behavior and activities (e.g., Hansen and Jarvelin, 2005; Hyldegård, 2006). Diaries have advantages in acquiring large amounts of data on participants' behaviors, interactions, feelings and thoughts (Hyldgard, 2006). Moreover, the researcher can use this method to track participants' information seeking activities and interactions as a tool of indirect observation (Wildemuth, 2002). However, one limitation is that it takes a long time to complete the diary entries and thus requires participants' continuous attention and persistence. Therefore, it is difficult to obtain a complete diary from participants (Riemen, 1993; Hyldegård, 2006). Corti (1993) stressed that the diary should be designed to be easy to use and control in order to increase participants' compliance in documenting their information activities and outcomes (Corti, 1993; Hyldgard, 2006). Thus, although researchers can use the diary method as a useful tool to retrieve data, it has both pros and cons for their research (Wildemuth, 2002).

2.4   Summary

This study examined how graduate students seek and use information in group-based work and how other factors, such as social, cognitive, and level of collaboration, affects their collaborative seeking behavior. In addition, this study explored whether the behavior can be explained by the application and expansion of information seeking behavior model and a CIB model.

Based on the problem addressed in this study, the theoretical foundation of this study was Kuhlthau's ISP model and Yue and He's CIB model. The influencing factors were perceptions of collaboration levels, types of support needed, other factors (e.g., cognitive and social factors) and students' background (gender, degree program, and previous experience in group projects and perception of the work).

To provide a framework for discussion in the area of collaborative information seeking, Kuhlthau's ISP model was used as one of the main frameworks. Although her model is focused on an individual's information search process, this study applied the model to the individual's information search process in a collaborative setting and explored how group members exhibit information seeking activities in the model throughout the group-based research project.

In accord with Yue and He (2010), the focus was on participants' information behaviors, perceptions of collaboration levels, types of support needed, and other factors (e.g., cognitive and social factors). In this study, cognitive factors include students' perceived knowledge of the research topic and perceived task difficulty. According to Karunakaran, Spence, and Reddy (2010), lack of domain capability and knowledge can affect the collaborative information behaviors between group members. Task difficulty refers to students' perceptions of difficulty, which has been found to more heavily influence performers' information behaviors, such as the

need for problem formulation and the pursuit and use of information accordingly (Ingwersen & Jarvelin, 2005). In addition, social factors, including different degrees of familiarity and communication with other collaborators, existed differently in each process of a collaborative work task (Yue & He, 2010), which may be related to performers' perceptions of collaboration levels. Also, because this research was conducted in an embedded setting, certain factors, such as student demographics, student experience, and communication tools, may have influenced students' information seeking activities and perceptions.

CHAPTER 3

RESEARCH METHOD

3.1   Introduction

This chapter presents an explanation of the methodological approaches used to answer the following research questions:

1. In which ways do group members exhibit information seeking activities throughout the group-based research project?

    1.1 How are the cognitive factors related to group members' information seeking activities throughout the group-based research project?

    1.2 How are the social factors related to group members' information seeking activities throughout the group-based research project?

2. In which ways do group members have different perceptions of collaboration levels throughout the group-based research project?

    2.1 How are the cognitive factors related to their perceptions of collaboration levels?

    2.2 How are the social factors related to their perceptions of collaboration levels?

3. In what ways do group members require collaborations or supports from peers to solve their difficulties or problems throughout the group-based research project?

Research methods commonly used for research on students' information behavior include questionnaires, interviews, observations, journals and search logs, since a researcher is able to conduct and mandate various research designs under his/her control and explore students' various aspects of collaborative information activities including individual and group behaviors. Therefore, to achieve this, many information behavior studies have been undertaken in quasi-

experimental settings. This study has developed multiple strategies for collecting data, including a background survey, behavior survey, and records of synchronous chat rooms and discussion forums. In addition, a pilot study was performed to develop the research design in the main study. Detailed below are the participants involved in this study, the research procedure, the instruments used to collect data, the processes employed to analyze findings, and the description of the pilot study.

3.2   Research Design

3.2.1   Participants

The total number of participants was 70 students in a two sections of a course in the spring semester of 2012 at a large public university. The course delivery was blended, with both online and on-campus components. Although there was an official required face-to-face meeting at the beginning of group work in the course, most of the course contents and group work was supplied via an online learning system (Blackboard learning management system) that offered a variety of communication tools, such as email, discussion boards, and chat rooms. All participants were graduate students in library and information science (LIS), chosen because they possess the basic information literacy skills necessary to access information. Also, all participants had met basic requirements, such as previous experience in information technology and project assignments in collaboration.

Since this study collected data through human subjects, Human Subjects and Institutional Review Board (IRB) approval was required to ensure minimal the risk to human subjects. To avoid bias during the data collection, the participants were unaware of the full purpose of the behavior survey and communication tools used while the group worked in the course. At the end

51

of the semester, the researcher gave them an explanation about the purpose of this study, and

obtained consent forms from each participant via an online survey. Each student received an

invitation via Blackboard learning management system email. The email included an explanation

of the study and a link to an online survey on SurveyMonkey (see Appendix A). When potential

participants clicked the link on the invitation email, they were connected to a consent form for

choosing whether to include their surveys, chat logs, and messages posted on discussion forums

in the research data. Students who consented to having their behavior surveys included in the

study were never identified as participating in the research. To prevent connecting an individual

survey with the name or other identifying information about the student, a code number was

assigned to each student's completed survey.

3.2.1   Procedure

This study explored graduate students' information seeking and use when involved in a

group research project. As one of the required course assignments, the students were instructed to

work together in groups to research the challenges in a topic among six course related topics. The

length of the final paper was approximately 20-30 pages (1,400 words) for each group and lasted

for approximately eight weeks. During the project assignment, the team members were expected

to perform the entire project, from formulating the topic to searching related literature on the

topic, to collecting and sharing information, to writing a paper. At the beginning of the group

project, the instructor introduced research topics, and students were allowed to choose first

choice and second choice among the six topics for further investigation. Each group was

assigned to research a different topic. They were in 13 groups, which were formed as a five-

person group, five four-person groups, four three-person groups, and three two-person groups

according to their research project topics (see Table 3.1).

Table 3.1

Organization of Group Project

Group	Topic	Number of group members
G1	T2	3
G2	T1	3
G3	T4	4
G4	T3	4
G5	T4	3
G6	T5	2
G7	T4	2
G8	T3	3
G9	T3	4
G10	T2	2
G11	T2	5
G12	T2	4
G13	T4	4

3.3   Data Collection

In order to gain insight into graduate students' collaboration in information behavior for their group-based project, this study applied mixed methods for data collection. The integration of qualitative and quantitative methods in research on information seeking has become increasingly common (Bryman, 2006a). Researchers have investigated how participants work and act together effectively in their groups by incorporating multiple methods. The strength of the mixed method for studying collaborative information behavior is useful for verifying the processes of attaining validity and obtaining various data from participants. Since it is hard to capture all behaviors and information and what they actually achieve in observation with a single

method, many researchers have considered using multiple methods to achieve more valuable results in social research (Reddy & Jansen, 2008). Therefore, many researchers have applied multiple techniques in their studies to enhance understanding of information behavior in collaboration. This study employed a background survey, a behavior survey, and online communication texts as data collection methods (see Table 3.2).

3.3.1 Background Survey

Before beginning the group project, students completed a background survey in the Blackboard learning management system. The survey contained four closed-ended items to collect data on students' gender, degree program level, previous experience with group-based projects, and perception of group work. (Appendix B). All responses were collected at the end of the semester.

3.3.2 Behavior Survey

To obtain behavioral data associated with individual information seeking, as well as with the research project and collaborative work over time, students in each group were asked to fill out a behavior survey at three points (i.e., initiation stage, mid-point stage, and completion stage). The behavior survey was used as an alternative method for observing the students. Reviewing the participants' personal recordings in regard to the questions was a useful way of obtaining a wider variety of responses to better understand their collaborative information activities.

Table 3.2

Research Design: Types of Factor

Research questions	Types of factors					Instruments and types of data			Types of data analyses		
	info-seeking activities	cognitive	social	collabo level	collabo problem solving	background survey	behavior survey	online comm texts	descriptive statistics	statistical tests	content analysis
1. In which ways do group members exhibit information seeking activities throughout the group-based research project?	○						4	text	○		○
1.1 How are the cognitive factors related to group members' information seeking activities throughout the group-based research project?	○	○					1, 2, 4		○	○	
1.2. How are the social factors related to group members' information seeking activities throughout the group-based research project?	○		○				3, 4		○	○	

(table continues)

Table 3.2 *(continued)*

Research questions	Types of factors					Instruments and types of data			Types of data analyses		
	Info-seeking activities	cognitive	social	collabo level	collabo problem solving	background survey	behavior survey	online comm texts	descriptive statistics	statistical tests	content analysis
2. In which ways do group members have different perceptions of collaboration levels throughout the group-based research project?				○			6		○	○	
2.1. How are the cognitive factors related to their perceptions of collaboration levels?	○			○			1, 2, 6			○	
2.2. How are the social factors related to their perceptions of collaboration levels?			○	○			3, 6			○	
3. In what ways do group members require collaborations or mediations from peers to solve their difficulties or problems throughout the group-based research project?					○		5	text	○		○

The survey contained both closed- and open-ended items. The participants were asked to indicate their information seeking activities in group-based research processes, perceptions about their collaboration, and interventions or supports from their peers during the project. By collecting the survey data from individuals, it was possible to observe each member's different perceptions and experiences with the information seeking behaviors and group work.

The contents of the survey items were based on Kuhlthau's ISP model and Yue and He's CIB model. Also, the degree of collaboration levels was based on the study by Frey, Logmeier, Lee, Tollefson and Johanning (2004). The survey was primarily created based on the Student Learning through Inquiry Measure (SLIM) toolkit developed by Todd, Kuhlthau, and Heinstrom (2005). The SLIM toolkit is intended to track changes in individual students' information seeking behavior and to measure their perceived knowledge, perceived difficulty, and satisfaction at each stage of the project. In this study, the questions in the toolkit were modified to meet the purpose of this study. In the pilot study, regarding the question for the group members' contributions during group project, participants tended to provide problems between group members or in group works rather than about their contributions and information seeking activities during their group works. So, there was difficulty in capturing the behavioral differences between the stages of the group projects via the reflective journals. Therefore, it was determined that the open-ended question was replaced by the closed-ended item to observe the students' behavioral differences between each stage of the research project using Kuhlthau's (2004) information seeking activities. In addition, in the process surveys of the pilot study, the closed-questions for perceived knowledge and difficulty of the topic were decided to use in this study since the questions were considered as the important factors to explore the relationships among group members' information seeking activities, and understanding of the topic. Also, using these data, the study

57

explored how students' perceived collaboration levels, perceived familiarity with group members, and collaborative problems and solutions changed over time. These have been identified in the previous literature and some factors are expected to be identified in this study as new influencing factors (see Table 3.3).

Five closed-ended items each employed 5-point Likert scales. The scale for understanding of the topic and familiarity with group members was 1) *not at all*, 2) *not much*, 3) *somewhat*, 4) *quite a bit*, and 5) a *great deal*. The scale for perceived difficulty of the project was 1) *very easy*, 2) *easy*, 3) *moderate*, 4) *difficult*, and 5) *very difficult*. The degree of perceived collaboration was scaled from 1 (low) to 5 (high).

For the question pertaining to information seeking activities in collaboration, respondents were asked to record which tasks they worked on with group members when seeking and using information. To collect participants' thoughts and opinions, the open-ended items allowed for greater flexibility in collecting data (see Appendix C).

3.3.3   Online Communication Texts

The researcher closely observed the students' research process while using the chat rooms and discussion boards. Since this study was undertaken in a setting of mostly online-based group work, these communication tools played very important roles to accomplish a group work task. Several studies in collaboration have been conducted by employing chat or instant messaging in group work (e.g., Handel & Herbsleb, 2002; O'Neill & Martin, 2003; Quan-Haase, Cothrel, & Wellman, 2005; Shah & González-Ibáñez, 2010). According to Quan-Haase, Cothrel and Wellman (2005), the use of chat or instant messaging leads to higher connectivity and new structures of collaborative work.

58

Table 3.3

Types of Factors in the Study

Types of factors	Factors	Literature sources
Student background	1) Gender 2) Degree program 3) Prior experience with group assignment 4) Feeling about prior experience with group assignment	-----
Information project stages	1) Initiation 2) Midpoint 3) Completion	Todd, Kuhlthau, and Heinstrom (2005)
Information seeking activities	1) Discussing topic or information needed with group members 2) Formulating questions based on information needed 3) Identifying key concepts and terms that explain information needed 4) Exploring general information sources to increase familiarity with topic 5) Intentionally seeking possible focuses and locating relevant information 6) Reading information found to learn about the topic 7) Outlining to organize information 8) Formulating a focus from the information encountered 9) Gathering information that defines, extends, and supports the focus 10) Writing about themes and ideas 11) Rechecking sources for information initially overlooked 12) Other	Kuhlthau (2004)
Online communications	1) Research (topical) message 2) Social message 3) Procedural message	Jahng, Nielsen, and Chan (2010)
Cognitive dimensions	1) Perceived knowledge of research topic 2) Perceived task difficulty of research project	Todd, Kuhlthau, and Heinstrom (2005) Yue and He (2010)
Social Dimensions	1) Degrees of familiarity with group members 2) Perceptions of collaborative levels	Yue and He (2010) Frey, Logmeier, Lee, Tollefson, and Johanning (2004)

In this study, the data from chat rooms and discussion boards were used to keep track of the students' research process, and the methods used for collaboratively seeking and using information throughout the project. In addition, this research was focused on the number and content of messages exchanged and recorded in each work process to explore participants' affective perception and usage of the systems to coordinate information seeking, such as initiating a task and discussing strategies.

3.4   Data Analysis

3.4.1   Background Survey

Quantitative data from the background survey were summarized in descriptive statistics and used in statistical tests comparing student demographics to behaviors.

3.4.2   Behavior Survey

Likert-scale data from the closed-ended items in the three iterations of the behavior survey were summarized in descriptive statistics and analyzed with t-tests, ANOVA, Pearson coefficient correlation, and chi-square tests. All statistical tests were conducted using SPSS.

3.4.3   Behavior Survey Texts

All text-based data from the open-ended items were unitized at the sentence level for analysis. Inductive content analysis yielded 13 categories of collaboration problems and 7 categories of collaboration solutions. The coding schemes are shown in Tables 3.4 and 3.5.

Table 3.4

Coding Scheme for Collaboration Problems

Category	Examples
Arranging Meeting Time	"Finding a time difficult when everyone is available" (S33)
Communicating with group members	"Communication is only a problem that we have encountered." (S15)
Focusing the topic	"focusing the topic is difficult in our group work" (S12)
Scoping or formulating the project	"With such a big topic, it was difficult for us to narrow it down." (S5)
Using communication technologies (technical problem)	"The main problem has been with Blackboard's chat feature. I was unable to get into the chat." (S30)
Managing time to work or project	"Managing time to work with other group members is very difficult in group-based project." (S15)
Dividing jobs among group members	"We have had trouble cleanly dividing our topic into sections we can research individually." (S9)
Understanding the concept or idea	"This is a broad-ranging topic and so the challenges section to understanding topic is especially hard." (S38)
Organizing and writing paper	"One of the problems was organizing the paper and deciding who writes the different parts." (S30)
Seeking relevant materials	"Seeking specific and relevant articles are problems" (S08)
Low activities of group members	"I have seen very little work or communication." (S03)
Do not have any problem	"We did not encounter any problems as such." (S22)
Other	"Expecting different personal level for this project"(S25)

Table 3.5

Coding Scheme for Collaboration Solutions

Category	Examples
Scheduling meetings on weekends	"All members don't have time during week, so we decided to meet at weekends by online." (S04)
Meeting online using alternative communication tools	"I was able to follow the chat log. I notified another of my group via phone about the problem and I was following the discussion." (S30)
Dividing sections of project among group members	"We worked to divide up certain sections, and that helped the process go more smoothly." (S5)
Depending on group leader for direction	"Our group leader decided to assign each of us section to solve this problem." (S37)
Discussing the problems with other group members	"By discussing at each meeting our current thoughts on the divisions and how they overlap" (s05)
Working together with other group members to find and share information they needed	"We are working together to help further define, outline, and find information for this section of the paper" (S16)
Other	"Did not consult the group to solve my problem" (S19)

To ensure the reliability of the qualitative results, the coding schemes were assessed for intercoder reliability, which applies agreement among experts as evidence of the value of the information they provide (Krippendorff, 2012). In this study, the author acted as primary coder for all data on collaboration problems and solutions, and two other individuals independently coded 30% of the data. For collaboration problems, the agreement across all three coders was 90.3%, with pairwise agreements ranging from 82.8% to 100%. For collaboration solutions, the agreement across all three coders was 93.8%, with pairwise agreements ranging from 84.5% to

100%. Based on a rule proposed by Neuendorf (2002), this study used 80% agreement as the cutoff point. Therefore, the data resulting from use of these coding schemes were judged to be reliable.

3.4.4   Online Communication Texts

To analyze data for the online communication texts, all chat rooms and discussion forum messages relating to the group project and generated during the three stages of the project (initiation, mid-point, and completion) were unitized at the sentence level (Henri, 1992) and categorized with respect to parts of Jahng, Nielsen, and Chan's (2010) classification. In this study, some of their categories were changed to make them more appropriate for the research questions: 1) research-related messages about planning and coordination of collaborative information seeking behavior, 2) social messages about students' perceptions, interests, and lives beyond their collaborative work, and 3) procedural messages about managing the collaborative process and arranging meetings. The coding scheme is shown in Table 3.6.

To verify the reliability of the text-based data, the online communication texts were also assessed for intercoder reliability by using the coding schemes from Jahng, Nielsen, and Chan's (2010) study. The author acted as primary coder for all contents, and 30% of these contents were coded by the other two coders. By percent agreement analysis, the agreement across all three coders was 88.3%, with pairwise agreements ranging from 81.2% to 100%. Based on a rule proposed by Neuendorf (2002), this study used 80% agreement as the cutoff point. Therefore, the data resulting from use of these coding schemes were judged to be reliable.

Table 3.6

Coding Scheme for Online Communication Texts

Category	Examples
Research-related Messages : statements related to information search process content of group research project	Suggesting ideas on the assigned topics; sharing information about what they found; resolving conflicted opinions "Here are some articles that may be useful for our paper." (S03)
Social Messages : statements related to group membership and personal information; not related to the course tasks	Sharing personal information and feelings; greetings; humor or jokes; encouragement "How is everyone this morning? How is everyone doing?" (S14)
Procedural Messages: statements to handle the collaborative process and procedures about the project	Arranging and scheduling meetings; dividing jobs among group members; managing deadlines, paper limits, and other problems "We'll probably need another meeting later in the week before all of this is due. Let me know if Monday around 8 or 9 pm works for yall!" (S07)

3.5   Pilot Study

For the pilot research, a study was conducted in the two courses (Summer 2011 and Fall 2011) for the following purposes prior to the major dissertation study: 1) to assess research design and research instruments, 2) to prepare the researcher in implementing research instruments in a collaborative learning setting, and 3) to improve the final research design.

3.5.1   Participants and Procedure

Participants were graduate students in LIS enrolled in the same course in two different semesters (summer 2011 and fall 2011) at a large public. A total of 66 students (34 in summer and 32 in fall) participated in this study. As one of the required course assignments, the students were instructed to work together in groups to research the challenges in a course topic. The research project lasted eight weeks and the length of the final paper was approximately 20-30 pages for each group. During the project assignment, the team members had to perform the entire project, from formulating the topic to searching related literature on the topic, to collecting and sharing information, to writing a paper.

3.5.2   Data Collection

Before data collection, consent forms from the students were obtained. Data were collected through process surveys (summer 2011) and reflective journals (fall 2011) at the initiation, mid-point, and completion project stages. Also, the demographic data and online communication texts (i.e., discussion boards and chat rooms) were collected from the students.

The process surveys and reflective journals were created based on the Student Learning through Inquiry Measure (SLIM) toolkit developed by Todd, Kuhlthau, and Heinstrom (2005) to track changes in their information seeking behavior.

Through the process surveys, students were asked to respond about their perceived knowledge, difficulty, and interest of the topic at each stage of the group project. These were all comprised of closed-ended questions. Also, through the reflective journals, each student was asked to document the progress of his or her own information behavior and learning at the three stages of the group project. The items in the reflection journals consisted of all open-ended

questions including what the student or other group members contributed during the group

project and their difficulties or challenges during group project.

3.5.3   Data Analysis

All responses for closed-ended items from the process surveys were entered into SPSS

and analyzed to produce descriptive statistics and to assess *t*-test, ANOVA, and Pearson

coefficient correlation. The closed-ended items consisted of questions with a 5-point Likert scale.

For example, the scale for perceived difficulty of the topic was 1) *very easy*, 2) *easy*, 3) *moderate*,

4) *difficult*, and 5) *very difficult*. Similarly, students were asked to quantify their perceived

knowledge of their topic was 1) *nothing*, 2) *a little bit*, 3) *somewhat*, 4) *quite a bit*, and 5) *a lot* at

three points of their research process. Also, the scale for perceived interest of the topic was 1)

not at all, 2) *just a little*, 3) *somewhat*, 4) *pretty much*, and 5) *very much*.

Responses about the difficulty of the project from the reflective journal were identified

using inductive content analysis. A total of 11 categories of difficulties emerged: 1) Finding full

text article; 2) Time consuming to read all articles; 3) Working together with group members; 4)

Selecting or identifying relevant information from sources; 5) Formulating the scope of subject/

understanding about a topic; 6) Writing a paper; 7) Synthesizing/organizing information; 8)

Putting in keywords for searching information; 9) Finding useful information or literature; 10)

Narrowing the topic; 11) Other (statistics, research design, APA style, etc). The data for the

group contribution were also content analyzed, yielding categories related to cooperating

between group members, dividing group tasks, communicating with group members, writing a

paper, and sharing information.

3.5.4   Summary of Pilot Study

The pilot study was conducted research in two different settings as a precursor to the more extensive dissertation study. The results showed increases in the students' perceived knowledge about the research topic as they progressed through their group project and in their experiencing more pressure as the project progressed. Also, the increasing the level of perceived knowledge and difficulty about the topic affected their perceived interests of the topic. In addition, the results indicated that students who participated in collaborative work instigated the projects in positive ways. The results also revealed that students found the difficulty of the project to be highest at the mid-point of the project, and they seemed to be engaged in the project independently until the mid-point. More than half the students mentioned that they were anxious to work together with other group members at the completion point of the project, and some students reported problems, such as communicating with group members, synthesizing information, and combining several themes to a form, and writing a group paper.

The pilot study led to the development of the research design for the main study. During the group project in the pilot study, the students were required to keep reflective journals by recording their thoughts three times (at the initiation, mid-point, and completion) about what they contributed to their group project and difficulties or challenges in their group work. However, the reflective journals proved to be problematic for collecting detailed descriptions from the students. The participants did not provide detailed descriptions to each open-ended question in the reflective journals, so there was difficulty in capturing the behavioral differences between the stages of the group projects via the journals. Therefore, it was determined that the reflective journals would not be sufficient for the purpose of the main study, so the journals were replaced by the behavior surveys with both open- and closed-ended items to observe the students'

behavioral differences between each stage of the research project. A closed-ended item about

perceived knowledge and difficulty of the topic was added to the survey in the main study as a

way to explore the important relationships among group members' information seeking activities,

perceived collaboration level, and understanding of the topic.

The pilot study provided valuable insights and implications for the main study. The

researcher made some changes to the research questions about the graduate students'

collaborative information process in order to clarify how different social and cognitive factors

influence their information seeking and use behavior.

3.6   Summary

The methodological approaches used to answer the research questions have been

addressed in this chapter. In this study, researchers have developed multiple strategies for

collecting data, including a background survey, behavior survey, and records of synchronous chat

rooms and discussion forums. In addition, a pilot study was performed to develop the research

design in the main study.

Before beginning the group project, students were invited to complete a background

survey voluntarily to collect data pertaining to the students' background information, such as the

students' gender, degree program and previous experience with group-based projects. Responses

on the background survey were coded into numbers and analyzed using descriptive statistics.

To obtain behavioral data associated with group members' information seeking activities

in group-based research processes, perceptions about their collaboration, and interventions or

supports from their peers during the project, students in each group were asked to fill out a

behavior survey at three points (i.e., initiation stage, mid-point stage, and completion stage). The

closed-ended items from the three surveys were coded into numbers and evaluated using statistical analysis. All text-based data from the open-ended items were analytically coded through content analysis.

In addition, the data from chat rooms and discussion boards were used to keep track of the students' research process, and the methods used for collaboratively seeking and using information throughout the project. The data were analyzed using Jahng, Nielsen, and Chan's (2010) classification: 1) research-related messages; 2) social messages; and 3) procedural messages,

CHAPTER 4

RESULTS AND DISCUSSION

4.1   Introduction

This chapter presents the research findings on behavior patterns of graduate students involved in collaborative learning and problem solving, and how related factors affected their information seeking behavior during collaborative activities.

The first section presents the demographic characteristics of the participants and their previous experiences with group work. Before the students started the research project, they were asked to complete a background survey (Appendix B) that included items about gender, education level, and previous experience with and perception of group work.

The subsequent sections present the results for each of the three main research questions and four sub questions. Students were asked to complete a behavior survey (Appendix C) at three points during their group project. As members of 13 groups, they had access to online chat rooms and discussion forums to communicate with other group members. The results of analyses of data from the survey and online communications addressed the students' information seeking activities as well as social and cognitive experiences (i.e., perception of collaborative level, task difficulty, and familiarity with group members) related to the group project.

4.2   Participant Demographic

Out of the total 70 students enrolled in the course in the spring semester of 2012, 46 students completed the behavior survey all three times. Three of these students did not consent to include their data in this study and were excluded from the data analysis, leaving 43 (61.4%)

students. Of the 43 participants, 35 were female (81.4%) and 8 were male (18.6%). They were in 13 groups and each group was assigned to one of six research topics. The distribution was one five-person group, five four-person groups, four three-person groups, and three two-person groups, according to their choice of research topics.

In the background survey, students were asked if they had participated in any group assignments before and how they felt about their previous group work experience. All of the participants had previous experience with group-based work as a course requirement. More than half of the students (58%) said their previous experience with group work was positive and 16% said it was 5 very positive. Only 4% of the students indicated that their previous experience with group work was negative (see Figure 4.1).
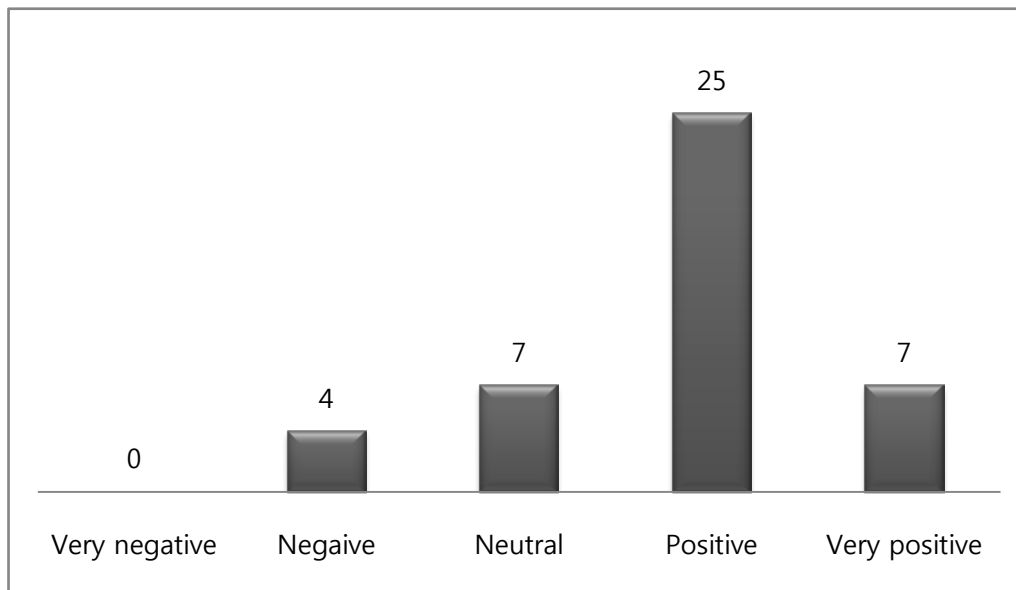
Figure 4.1. Perceptions of previous group-based work ($N = 43$)

4.3 Research Question 1: Information Seeking Activities in Group Project

- In which ways do group members exhibit information seeking activities throughout the

71

group-based research project?

In this section, the group members' information seeking activities in the collaborative research project are discussed in order of the process points of the project: initiation stage, mid-point stage and completion stage. Students were asked to complete the behavior survey about their information tasks, which identified the types of individual and collaborative information seeking activities.

In addition, students were asked to communicate with other group members through the discussion forum and chat room in the Blackboard learning management system, which allowed observation of their information seeking activities and interactions. Their online messages were categorized as research, social, and procedural.

4.3.1   Information Seeking Activities

The behavior survey was used to collect data on group members' information seeking activities. Students chose multiple tasks from the list of 12 (including "Other") provided for the following item, which was reworded slightly for each stage of the group project:

- *Initiation*: Since the beginning of this group project, what have been your tasks for the project?

- *Mid-point*: Since the last process survey, what have been your tasks for the project?

- *Completion*: Since the last process survey, what have been your tasks for the project?

Across the groups, the results showed different information seeking activities at the three stages of the research process. Some information tasks were activated on a collaborative basis, while there were individual-based information tasks. In addition, some information seeking

activities were generally exhibited by all group members, but others were handled by only a few group members. Thus, although this study explored each individual's information seeking activities in the group-based project, it may be revealed that not only individual based information seeking activities were engaged in, but group members' also exhibited information seeking behavior in collaboration.

At the initiation stage, 43 students completed the behavior survey with a total of 215 responses; including responses in all 12 categories (see Table 4.1). Out of the 43 students, 83.7% of students (36 out of the 43 students) reported "Discussing the topic or information needed with group members" as a main information activity for their group research project, and a similar percentage (79.1%, 34 students) of students indicated that "Explore general information sources to increase familiarity with the topic in a variety of formats (e.g., database, website, books)" was their main information activity at the initiation point. As the next largest proportion (65.1%, 28 students) of students indicated "Intentionally seeking possible focuses and locating relevant information," and 27 respondents (62.8 %) provided that their main information task was reading information found to learn about the topic at this point.

Surprisingly, four students reported "Writing about themes and ideas" (9.3%) and two students replied "Rechecking sources for information initially overlooked" (4.7%) as the main information tasks for their group research at the starting point. This could mean that some students focused on writing a paper and rechecking references from the starting point of their assignment.

Table 4.1

Information Seeking Activities in the Initiation Stage

Information seeking Activities	N	%
Discussing the topic or information needed	36	16.8
Formulating questions	13	6.1
Identifying key concepts	23	10.7
Exploring general information sources	34	15.9
Seeking and locating relevant information	28	13.0
Reading information found	27	12.6
Outlining to organize information	10	4.7
Formulating a focus	5	2.3
Gathering information	15	7.0
Writing about themes	4	1.9
Rechecking sources	2	1.0
Other	13	6.1
Total	215	100

In this item, the students were allowed to select multiple choices with an option for "Other" to be filled in if another idea was not listed among the information seeking activities. 30.2% of students chose "Other" for the categories in this item. Most responses in this category were about "Managing overall group work" and "Setting up communication tools for collaboration." To guarantee anonymity, students' identification numbers are presented as 'S#' instead of their names.

Students said:

SD28: I am the group organizer. As such, I have set up the Google Docs (one for the

paper and one for the progress report) that we are working on. I also have

kept track of who posts in the discussion board. I am also responsible for

researching and writing on scanning and preservation in [topic 4].

S40: Trying to organize efforts. Organized chat time.

S19: Organizing meeting times and directing group activity.

When looking across groups, the information seeking activities at the initiation stage was generally associated with "Discussing the topic," "Exploring general information relates the topic," "Seeking and locating information" as well as "Reading information found." In a few cases, group members started to work on formulating a focus and writing the pre-focused ideas and themes on paper at the beginning of the research project. Overall, at the initiation stage, in order to find the focus of the project topic, students tended to discuss the topic and explore general resources together with other group members before dividing the project into specific parts for further work on an individual basis.

At the mid-point stage of the research process, a total of 284 responses were checked by 43 students, and that was the highest number of responses among the three stages (see Table 4.2). During this process, group members were engaged in a higher overall proportion of information seeking activities with a very similar proportion for responses. There were also no responses which were never checked among the twelve categories.

Group members were mainly assigned the information task of "Reading information found to learn about the topic" (79.1%, 34 out of the 43 students), followed by "Explore general information sources to increase familiarity with the topic in a variety of formats" (72.1%, 31

students), and "Discussing the topic or information needed with group members" (69.8%, 30 students) at the mid-point stage of research process.

Table 4.2

Information Seeking Activities in the Mid-point Stage

Information seeking Activities	N	%
Discussing the topic or information needed	30	10.6
Formulating questions	17	6.0
Identifying key concepts	24	8.4
Exploring general information sources	31	11.0
Seeking and locating relevant information	29	10.2
Reading information found	34	11.9
Outlining to organize information	25	9.0
Formulating a focus	23	8.1
Gathering information	26	9.1
Writing about themes	23	8.1
Rechecking sources	15	5.3
Other	7	3.0
Total	284	100

The lowest proportion of respondents were assigned to the task of rechecking sources for information initially overlooked at this process (34.9%, 15 students) and "Other" (16.3%, 7 students). Most of the responses in the "Other" category were about searching for any additional information and dividing tasks.

Students said:

S34:   Identifying the information need for any additional information sources.

S18: Write an individual section especially on the topic and I searched for additional sources for paper.

In this stage, information tasks were more evenly distributed across students, since each group member was assigned specific parts of the project. However, students were primarily associated with "Reading information found," "Exploring general information relates the topic," and "Discussing the topic." Reading information is related to the purpose of getting new knowledge, so this task may be connected to the tasks of exploring, seeking and gathering background and relevant information to get more specific ideas about the topic. Therefore, each member was engaged in the overall information seeking activities, such as problem solving activities, searching for specific information, and reading and writing on the specific topic in focus at the mid-point stage.

At the completion stage, a total of 268 information tasks were selected by the 43 students, and there were no responses which were never checked among the twelve categories (see Table 4.3).

The majority of students had undertaken "Writing about themes and ideas on their group paper" (86.0%, 37 out of the 43 students). The next largest proportion (69.8%, 30 students) of students indicated that they were mainly "Rechecking sources for information initially overlooked."

However, many respondents revealed that they were still discussing the topic or information needed with group members (58.1%, 25 students) and gathering information that defines, extends, and supports the focus (58.1%, 25 students) at the completion stage of the project.

Table 4.3

Information Seeking Activities in the Completion Stage

Information seeking Activities	N	%
Discussing the topic or information needed	25	9.3
Formulating questions	15	5.6
Identifying key concepts	20	7.5
Exploring general information sources	14	5.2
Seeking and locating relevant information	19	7.2
Reading information found	21	7.8
Outlining to organize information	17	6.3
Formulating a focus	21	7.8
Gathering information	25	9.3
Writing about themes	37	13.8
Rechecking sources	30	11.2
Other	24	9.0
Total	268	100

As for the other choices, the majority of students mentioned they were engaged in information seeking activities of identifying the need for any additional information and editing and formatting the final paper.

Students said:

S13: Help with APA formatting on final submission.

S17: Combining information from all the papers to formulate an introduction;

proofreading the paper.

S24: I also have started to knit all of the parts together into a cohesive paper.

S27: Editing our own and reading the other sections, double checking references

and Looking for additional things to fix.

When group members were searching for information at the completion of the research project, they were still engaged in overall information seeking-related activities. However, their primary information tasks were completing the writing of the paper and verifying cited references for the paper. It is interesting to note that some formulation of information and problem solving activities, such as formulating a focus, discussions on the topic, and identifying key concepts, were performed continuously by students during the three stages of the research project. This perhaps means that the students tried to be more focused and have a better understanding of the topic as the research project progressed.

In summary, group members' information seeking activities initiated with discussing the topic and exploring general information, and at the mid-point, they were concerned mostly about seeking and gathering information related to the topic and reading the information gathered. At the completion stage, they focused on the specific problem and writing the paper. In general, the number of group members' information search activities decreased as the project progressed, while the activities of checking information found and writing the paper increased as the project progressed. Figure 4.2 presents group members' general information seeking activities in each stage of research process.

When comparing group members' general information seeking behavior in Kuhlthau's ISP model, their information seeking activities were in line with her model. Hence, the group members' information seeking activities tracked the general stages in the ISP model. Hyldegård's (2009) study about the similarities between group members and the individual in Kuhlthau's ISP model are supported by the results of this study.

Information Seeking Activities

Initiation   Mid-point   Completion

Others
- 13(30.2%)
- 7(16.3%)
- 24(55.8%)

Rechecking Sources
- 2(4.7%)
- 15(34.9%)
- 30(69.8%)

Writing about themes
- 4(9.3%)
- 23(53.5%)
- 37(86.0%)

Gathering Information
- 15(34.9%)
- 26(60.5%)
- 25(58.1%)

Formulating a Focus
- 5(11.6%)
- 23(53.5%)
- 21(48.8%)

Outlining to Organize Information
- 10(23.3%)
- 25(58.1%)
- 17(39.5%)

Reading Information Found
- 27(62.8%)
- 34(79.1%)
- 21(48.8%)

Seeking and Locating Relevant Information
- 28(65.1%)
- 29(67.4%)
- 19(44.2%)

Exploring General Information Sources
- 34(79.1%)
- 31(72.1%)
- 14(32.6%)

Identifying key Concepts
- 23(53.5%)
- 24(55.8%)
- 20(46.5%)

Formulating Questions
- 13(30.2%)
- 17(39.5%)
- 15(34.9%)

Discussing the Topic
- 36(83.7%)
- 30(69.8%)
- 25(58.1%)

Figure 4.2. Information seeking activities by project stage

I   In Hyldegård's study, individuals' and group members' information search behavior was not statistically significantly different in the academic setting. Also, she said the information activity is influenced by the process of the assignment and other factors, such as work tasks and group work. In addition, in this study, some students tended to not track to only one direction of the stages in the ISP model. For example, when students felt that they had not fully understood their topics, they returned to the previous step to explore relevant information in order to better understand the topics.

These findings are quite similar to the Vakkari's (2001) and Kuhlthau's (2004) studies. Vakkari explored students' information problem stage while writing a research proposal. Regarding the research process, he have concentrated Kuhlthau's ISP model into three stage of research process as the 'pre-focus', 'focus' and 'post-focus' stage. The pre-focus stages contained the steps of initiation, selection and exploration, and the focus formulation included the activities of searching for specific information. As well, the post-focus stages contained the steps of collection and presentation. He found that at the pre-focus stages students were generally searching for background information and theories for outlining their research proposal, but they still mostly sought more specific information about background and theories of the topic to obtain a clearer understanding at the focus formulation stage. Kuhlthau (2004) also found that although the six stages in the ISP model are sequential, users may repeat stages, depending on their level of uncertainty during their information search process.

4.3.2   Individual Online Communications

The texts of group members' online communications during the group project were content-analyzed in order to better understand interactions during collaborative information

seeking. Both the number of messages posted in the chat rooms and discussion forum and the types of messages were informative when compared across project stages. The three categories of messages reflected the focus of student interactions: 1) research, pertaining directly to the project; 2) social, pertaining to personal information outside the project; and 3) procedural, pertaining to collaborative and research processes. Table 4.4 shows numbers and types of online messages (chat rooms and discussion forum combined) during the project stages.

The 13 groups posted 942 messages to the discussion forum and 1,552 messages to the chat rooms. However, Group 8 members did not use the discussion forum at all and only Groups 9 and 11 used the chat rooms. Group 6 used Google Docs as a communication tool instead of the chat rooms. In this study, the records in Google Docs were regarded as chat logs, so three groups' (Group 6, 9 and 11) records of Google Docs and chat logs were counted. The three groups met an average of 4.7 times during the research project, and engaged in an average of 517.3 conversations, which were coded into 643 units. Although the students interacted with group members using other media such as phones, email, and face-to-face meetings, these could not be tracked and so were not recorded in this study.

Students were asked to use the group discussion forum and chat rooms in the Blackboard learning management system, and most of the recorded communication for the collaboration process showed that students' communication occurred via email messages and other tools, such as Google Docs and Wikispaces. It appears that students were more comfortable using them than using the discussion forum or chat rooms in the Blackboard learning management system. In the overall communications of 13 groups, there was a higher level of activity during the completion of the project (55%) than the initiation and mid-point (see Figure 4.3).
.

Table 4.4

Online Communication Messages by Type and Project Stage

	Initiation			Mid-point			Completion			
Group	**Research**	**Social**	**Procedural**	**Research**	**Social**	**Procedural**	**Research**	**Social**	**Procedural**	**Total**
1	10	34	68	23	17	41	16	46	65	320
2	4	0	0	8	28	21	17	23	16	117
3	2	13	25	13	10	19	41	26	29	178
4	18	6	40	11	2	19	24	29	10	159
5	10	1	6	4	7	43	48	32	21	172
6	5	5	7	1	0	0	0	0	0	18
7	3	16	16	2	3	2	3	1	0	46
8	0	0	0	0	0	0	0	0	0	0
9	14	22	43	8	18	11	135	126	32	409
10	1	1	4	1	0	0	17	2	13	39
11	18	34	20	20	17	47	156	123	38	473
12	19	39	77	13	20	69	69	58	75	439
13	0	0	9	26	17	49	62	37	43	243
Total	104	171	315	130	139	321	588	503	342	2613

Students engaged in a variety of online communications associated with the research project. As with the behavior survey, the findings varied according to the stage of the project. Figure 4.3 shows the numbers and types of online messages (chat rooms and discussion forum combined) during the three project stages.

	Initiation	Mid-point	Completion
Research	104	130	588
Social	171	139	503
Procedural	315	320	342
Total	590	589	1433
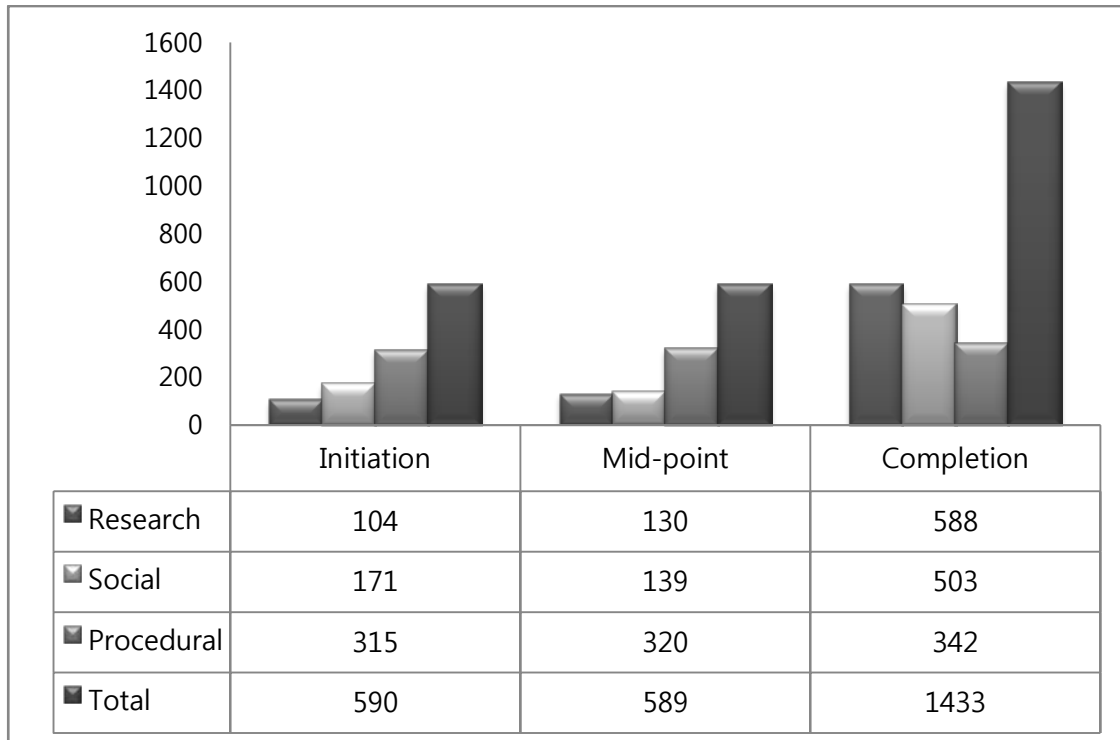
Figure 4.3. Online communication messages by type and project stage

At the initiation stage, a total of 187 postings were coded into 590 meaningful units. More than half the postings contained procedural content (315 units, 53.89%), followed by social content (171 units, 28.98%) and research content (104 units, 17.63%).

As indicated by the quantity of message interactions in this stage, students exchanged almost two or three times the number of social and procedural messages compared to the messages of topical content. Such a result implies that students may have tended to focus more

on sharing personal feelings and information as well as managing scheduling, discussing strategies and procedures about the project than interacting via messages directly related to information about their project at the initiation.

The high proportion of messages in the category of procedural message shows that group members tended to engage in information seeking activities for the individual work. Therefore, before the individual work commenced, there were many messages between group members at the initiation stage related to the collaboration process for dividing their jobs and sharing information found. When they reflected on the experiences of the research project, suggesting and discussing ideas on the assigned topic and formulating questions based on the information needed were prominent among messages related to information behaviors during the initiation stage. In this stage, group members suggested ideas or shared knowledge about what they had found, and evaluated opinions by agreeing or disagreeing with each other. Thus, they tended to mainly behave for topic selection and focused on exploration of information, as well as planning and dividing tasks. For example:

- I'll pick some different articles to read, and hopefully between the four of us we'll have a better idea about our topic.

- I have read some articles. I think # 2, 4 & 6 are good to get an idea of how personalization can be defined and implemented, and #5 is a good one to learn about the history/background of personalization.

- Here's another example for section 4, it's a case study at a Health Sciences library.

Overall, more than half of their postings reflected messages associated with the collaborative process and procedure in an online learning environment, followed by social

message and research message at the initiation stage. In this stage, before the individual-based work, there were many messages pertaining to the collaboration process at the initiation stage for dividing their jobs and sharing information found between group members. When they reflected on the experience of the research project, suggesting and discussing ideas on the assigned topic and formulating questions based on the information needed were prominent messages of information seeking behaviors during the initiation stage. Thus, they tended to mainly concentrate on topic selection and focused on exploration of information, as well as planning and dividing jobs.

At the mid-point of the research project, the total number of postings (205 postings, 589 units) increased slightly from the initiation stage. The messages about collaborative process and procedure (320 units, 52.33%) and research-related behavior (130 units, 22.07%) somewhat increased whereas messages about social content (139 units, 23.06%) were less than in the initiation stage. As shown above, both categories of research and social message had a similar proportion during the mid-point research process.

Group members mainly posted the information tasks of finding background or definitions on the topic, and seeking intentionally relevant information. Thus, they used the communication tools to share the information which they found, and information sources to increase familiarity with the topic in a variety of formats and to read information found with the group members. Surprisingly, some members were still discussing the topic or information needed within the group at the mid-point stage of the research process. For instance:

- I have done a small amount of background reading to get an idea of what personalization in [topic 1] looks like, but I don't have nearly enough done to have a sense of what our paper should look like.

- John and I are working on reading articles and getting our heads around the topic.

- I've attached a word doc with citations for some additional articles that could be useful to you guys's sections. There's a few more implementations/case studies and at least one article about the future of [topic 2] that group member can maybe tie in with personalization specific ideas.

- Also, I was thinking if we can't find a ton of implementations/case studies, I can say something in section 3 about how a lot of the writings on personalization have been largely theoretical or studies conducted with small groups of people, but there are a few implementations that will be discussed in the following section.

At this point of the research project, the total postings were higher than at the initiation stage. The postings about procedural and research messages somewhat increased whereas the postings regarding social message were less frequent than in the initiation stage. Group members mainly posted the task of finding background information or definitions of the topic, and seeking intentionally relevant information. Also, each group member was engaged in searching for information, and reading and writing his or her assigned specific part of the project. Therefore, the communication was mainly related to sharing information on what each member found and reading information on the specific topic in focus.

At the completion point, students' overall postings in three categories increased, but the postings regarding research-related behavior (588 postings, 41.03%) made up the highest proportion, unlike the previous stage. The next highest proportion was social communications (503 postings, 35.13%), and procedural messages had the lowest percentage (342 postings,

87

23.9%) at this stage. Perhaps this is because most students tended to focus on the information seeking activities of verifying references and rechecking if there was a need for any additional information among group members as part of the writing process. For example:

- I think we have enough material that it's not really necessary, plus I think my brain is on it's last legs. I must conserve the rest to format everything and proof/edit!

- For some reason I thought APA said no double-spacing, but now I see that I'm wrong. I also learned that you should single space after periods separating portions of the references, but not within sentences. :-S Off to fix that, and then I'll submit!

In addition, the group members used emoticons or joking comments several times at this point, and those increased as the project progressed. Also, they exchanged very personal messages which were not directly related to the research project. This perhaps means that group members felt more familiar and comfortable with each other, and they presented more emoticons or joking comments as an expression of awareness of group members during the research project.

At this point in the process, students' overall postings in three categories increased, but the postings of research message made up the highest proportion, unlike the previous stage. The next highest proportion was social communications, and procedural communications had the lowest percentage at this stage. Perhaps this is because most students tended to focus on the research-related communications of verifying references and rechecking if there was any additional information needed as a part of the writing process to complete their project.

Overall, the descriptions in the initiation stage of the online communication were somewhat very broad research-related activities without an obvious aim for their information

seeking activities, while the descriptions at the mid-point and completion stages of the online

communication tended to be more focused on clear goals and patterns of information seeking

activities.

4.3.3   Group Online Communications

The changes of group collaboration during the group-based research project are

supported with the qualitative data from communication tools as well. The discourses among

group members during the three stages of the research project shows that their collaborative

information activities affected their overall willingness to engage in the group project. Figures

4.4 and 4.5 show the average number of messages posted by group members in discussion

forums and chat sessions.
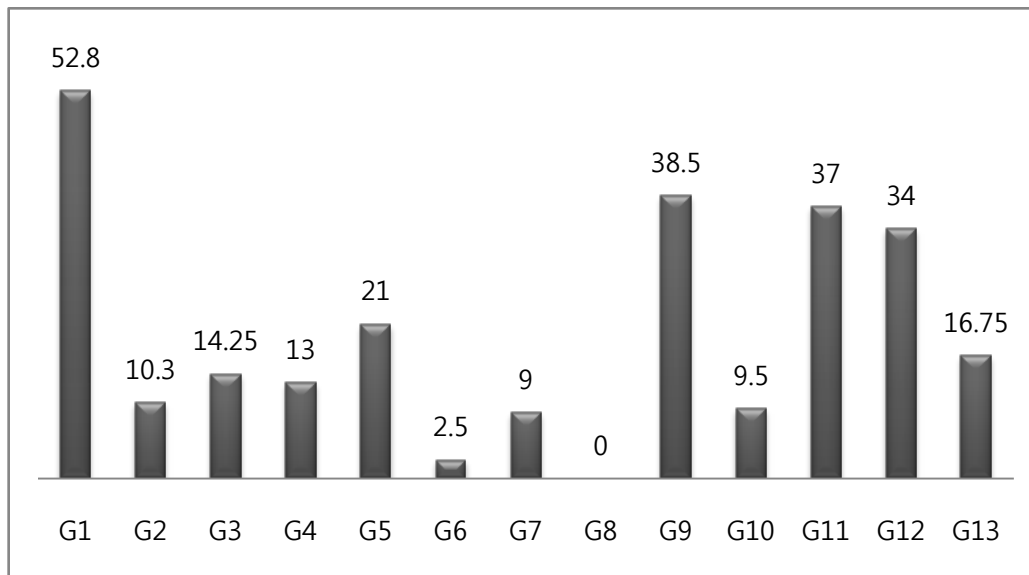
Figure 4.4. Average number per person of messages posted in discussion forums

To understand the collaborative information seeking activities, it is important to note how group members communicated with each other using the synchronous and asynchronous communication media. From the findings of the messages of the communication tools, it is apparent that communication with group members provided inspiration for learning in the group project.
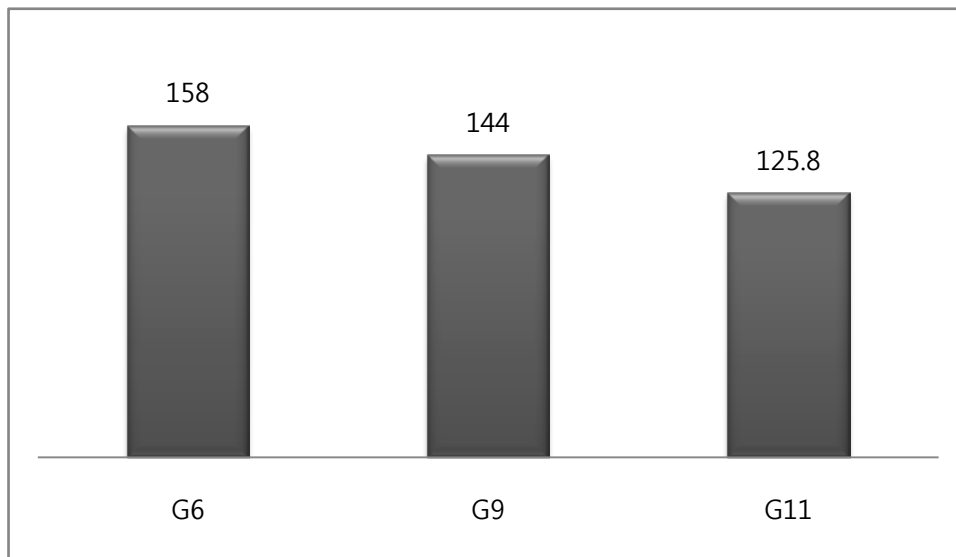
Figure 4.5. Average number per person of messages posted in chat rooms

Overall, Groups 1 and 9 exchanged more messages per person on average (52.8 and 38.5) than Groups 2, 7, and 10 (10.3, 9, and 9.5). Groups 9 and 12 exchanged more research messages on average (157 and 101) than Groups 7 and 10 (8 and 19). Groups 9, 11, and 12 had the highest average number of social messages (156, 174, and 117), while Groups 7 and 13 had the lowest average number (20 and 54). The procedural message category showed the most variation between groups, with Group 12 highest (221) and Group 7 lowest (18).

Group communication formed an important part of the constructive process of the research project. Various forms of communication were undertaken among group members during the research project according to the point in the process. Through exchanging comments, suggestions, related articles, and written papers among group members, each member used communication tools as an information source during the project. During the whole process, their communication occurred more frequently as the project progressed. It would seem that the students were getting more familiar with each other and gaining confidence. The increase in the social messages among group members also supported the result. Alavi and Dufner (2005) claimed that successful collaborative learning in a small group requires active interaction during group work. Hence, the communication medium was an important factor influencing group members' awareness of information behavior, social interaction, and collaboration.

4.4   Research Question 1.1: Cognitive Dimension

- How are the cognitive factors related to group members' information seeking activities throughout the group-based research project?

Students were asked to respond to two survey items intended to explore cognitive dimensions associated with the information seeking activities. The first item was "At this time, how well do you understand the topic of your group project?" The results are shown in Table 4.5.

Group members better understood the topic as they progressed in their research project. On average, they initiated their research with '3) *Somewhat*' understanding (M= 3.49, SD= .768) and became continuously more identified with the topic until the mid-point (M= 3.95, SD= .688) and completion (M= 4.63, SD= .578) of the project (see Figure 4.6).

Table 4.5

Perceived Knowledge of the Topic

How well do you understand the topic of your group project?	Initiation		Mid-point		Completion	
	N	%	N	%	N	%
Not at all	0	0	0	0	0	0
A little bit	3	7	1	2.3	0	0
Somewhat	20	46.5	8	18.6	2	4.7
Quite a bit	14	37.2	26	60.5	12	27.9
A lot	4	9.3	8	18.6	29	67.4
Total	43	100	43	100	43	100

	Initiation	Mid-Point	Completion
Mean	3.49	3.95	4.63
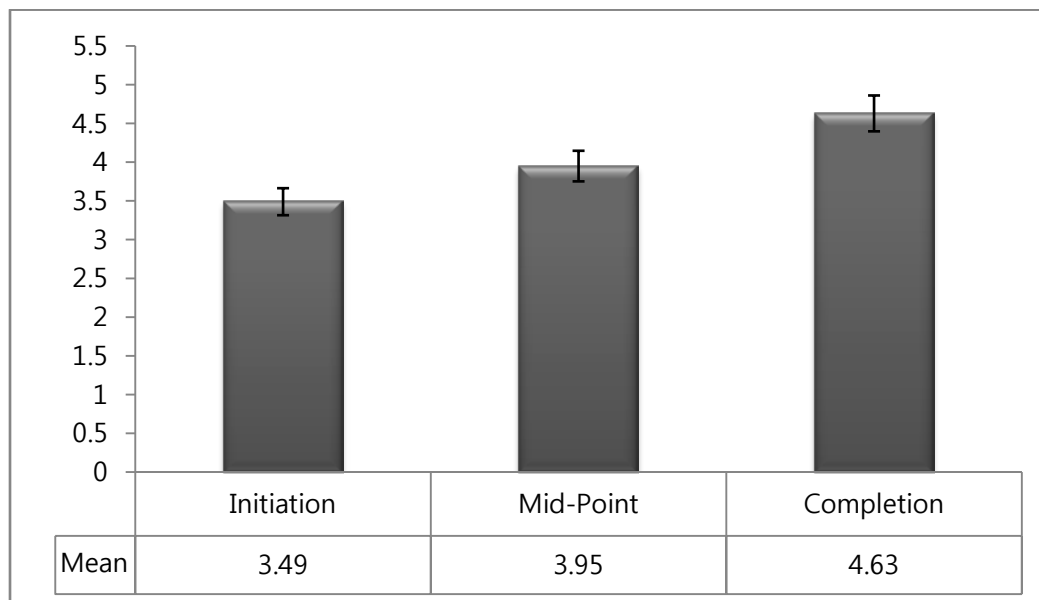
Figure 4.6. Mean changes in perceived knowledge of the topic ($N = 43$)

The result of a one-way ANOVA revealed that there were statistically significant differences in understanding of the topic among the three stages of the project ($F = 30.302$, $p < .05$). In addition, there were major increases in understanding of the topic between the

initiation stage and the mid-point stage, the mid-point stage and the completion stage, and the initiation stage and the completion stage.

- Initiation and Mid-point ($df = 42$): t = 2.957, $p < .05$

- Mid-point and Completion ($df = 42$): t = 4.814, $p < .05$

- Initiation and Completion ($df = 42$): t = 9.654, $p < .01$

The results showed group members' perceived knowledge of the topic significantly increased during the research project. This indicates that the group members' knowledge construction and formulation changed from weak and vague at the initiation of the project to more clearly identified and focused on the topic at the end.

The second item about the cognitive dimension was "At this time, how difficult do you think your group project is?" The item was also asked of students three times to explore the degree of perceived difficulty of the project at each point in the research process, and a 5-point scale was used, such as 1) *Very easy*, 2) *Easy*, 3) *Moderate*, 4) *Difficult*, and 5) *Very difficult*. Table 4.6 shows the group members' perceived difficulty of the project at each stage of the research process.

On average, they initiated their research with '3) *Somewhat*' difficulty (*M*= 3.16, *SD* = .531) and expressed more difficulty with the project until the mid-point (*M*= 3.33, *SD* = .566). But, at the completion stage, their perceived difficulty of the project was lower (*M* = 3.23, *SD* = .649) than compared with the mid-point of the project (see Figure 4.7).

Table 4.6

Perceived Difficulty of the Project

How difficult do you think your group project is?	Initiation		Mid-point		Completion	
	N	%	N	%	N	%
Very easy	0	0	0	0	0	0
Easy	2	4.7	0	4.7	4	9.3
Moderate	33	76.7	31	72.1	26	60.5
Difficult	7	16.3	10	23.3	12	27.9
Very difficult	1	2.3	2	4.7	1	2.3
Total	43	100	43	100	43	100

	Initiation	Mid-Point	Completion
Mean	3.16	3.33	3.23
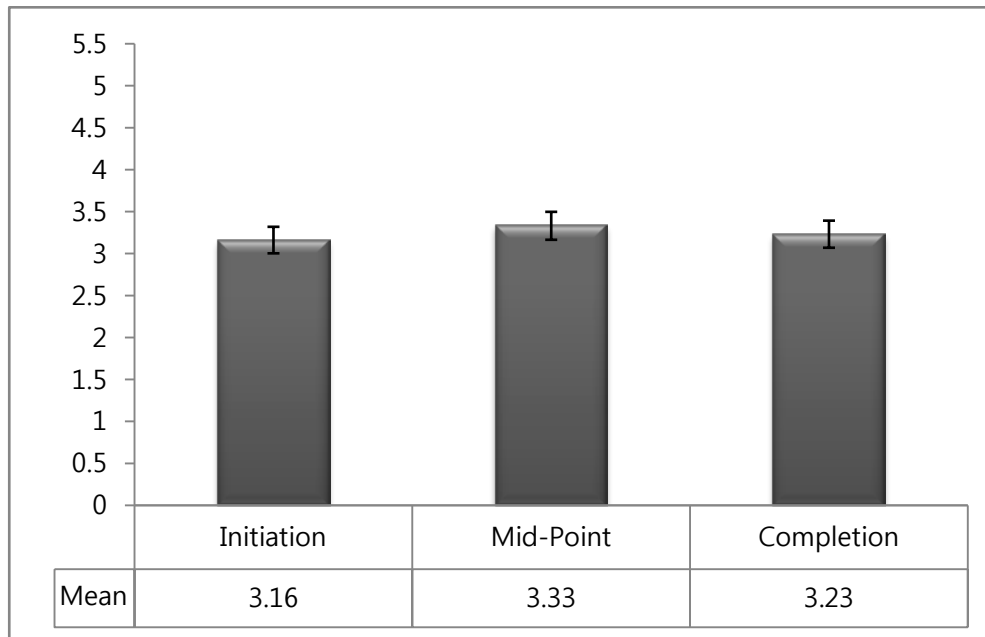
Figure 4.7. Mean changes in perceived difficulty of the project

The results of a one-way ANOVA and *t*-test revealed that there were not statistically significant differences in perceived difficulty of the project among the three stages of the project.

Whereas they initiated their research project with relative difficulty at the initiation stage, at the mid-point they perceived more difficulty with the project. However, their perceived difficulty of the project decreased at the end of the project when compared to the mid-point of the project. It would seem that most students began with uncertainty about the topic, and at the middle of the project many students perceived higher difficulty in searching further targeted information and finding general background resources. Hence, their perceived difficulty of the project increased toward the mid-point of the research project. At the final stage, they became clearer while tracking down specific and relevant information about their topic to complete their project, and they believed that they have reached the final stage of the project. So, their perceived difficulty of the project was lower than at the mid-point of the project. However, there were statistically significant differences among the three stages.

To determine the statistical relationship among group members' information seeking activities, perceived knowledge of the topic, and perceived difficulty of the project during the three stages of research process, a Pearson coefficient correlation and a chi-square test were calculated in this section.

First, at each stage of the research process, there was no relationship between the students' perceived understanding of the topic and their perceived difficulty of the project. This implies that regardless of their perceived knowledge and understanding of the topic, students exhibited personal perceptions of the difficulty on their project.

Second, a chi-square test indicated a statistically significant difference between students' information seeking activities and their perceived understanding of the topic at the mid-point stage ($\chi^2 = 59.248$, $p < .05$). Meanwhile, there were no differences between the group members' information seeking activities and their perceived understanding of the topic at the initiation and

completion stage. This implies that at the middle of the project, the perceived levels of understanding of the topic differed significantly in their information seeking activities. It revealed that when students perceived their knowledge of the topic as 'Quite a bit,' they exhibited the most information seeking activities, and their primary information seeking activities were discussing their topic, exploring general resources, and seeking relevant information at the middle of the project.

Finally, a chi-square test was conducted to evaluate the relationship between group members' information seeking activities and their perceived difficulty of the project. A statistically significant difference was found between in the group members' information seeking activities when comparing their perceived difficulty of the project at the mid-point ($\chi^2 = 22.096$, $p < .05$) and completion stage ($\chi^2 = 51.752$, $p < .05$). The results of the chi-square test indicated that the group members' perceived difficulty probably differed significantly in their information seeking activities at the mid-point and completion stage. The findings indicated that when the students perceived relative difficulty regarding their project, they showed that more information tasks were focused on reading information found and exploring general information sources at the mid-point of the research project. Whereas, students who revealed that the topic was very difficult tended to more frequently discuss their topic with group members. It seems that students who perceived more difficulty about the project were more likely to work together with other group members to solve the problem.

At the end of the project, most students perceived their topic as quite difficult, and they focused on writing the research paper and rechecking additional sources to complete the project. Meanwhile, students who felt their topic was difficult up to this point also demonstrated that they were still focused on discussing the topic with other group members. It is interesting to note that

whenever they perceived any degrees of difficulty on the project, they were primarily concerned with the writing task. This indicates that most students perceived themselves as knowledgeable about their topics at the time of the final writing task.

4.5   Research Question 1.2: Social Dimension

- How are the social factors related to group members' information seeking activities throughout the group-based research project?

To explore group members' social dimension, students were asked to respond their feelings about the familiarity with group members at three points of research process.

As shown in Table 4.7, students' familiarity with their group members as the research projects progressed increased slightly, but the degree of students' familiarity with their group members stayed between '3) *Somewhat*' and '4) *Quite a bit*' during all of the stages of the research process.

Table 4.7

Perceived Familiarity with Group Members

How intimate and familiar are you with your group members?	Initiation		Mid-point		Completion	
	N	%	N	%	N	%
Not at all	0	0	0	0	0	0
A little bit	5	11.6	5	11.6	0	0
Somewhat	26	60.5	18	40.6	9	20.9
Quite a bit	9	20.9	15	34.9	27	62.8
A lot	3	7.0	5	11.6	7	16.3
Total	43	100	43	100	43	100

The mean and standard deviations for perceived familiarity with group members are presented in Figure 4.8. On average, they initiated their familiarity with '3) *Somewhat*' difficulty ($M = 3.23$, $SD = .751$) and expressed more difficulty with the project until the mid-point ($M = 3.47$, $SD = .855$) and the completion of the project ($M = 3.95$, $SD = .615$).

	Initiation	Mid-Point	Completion
Mean	3.23	3.47	3.96
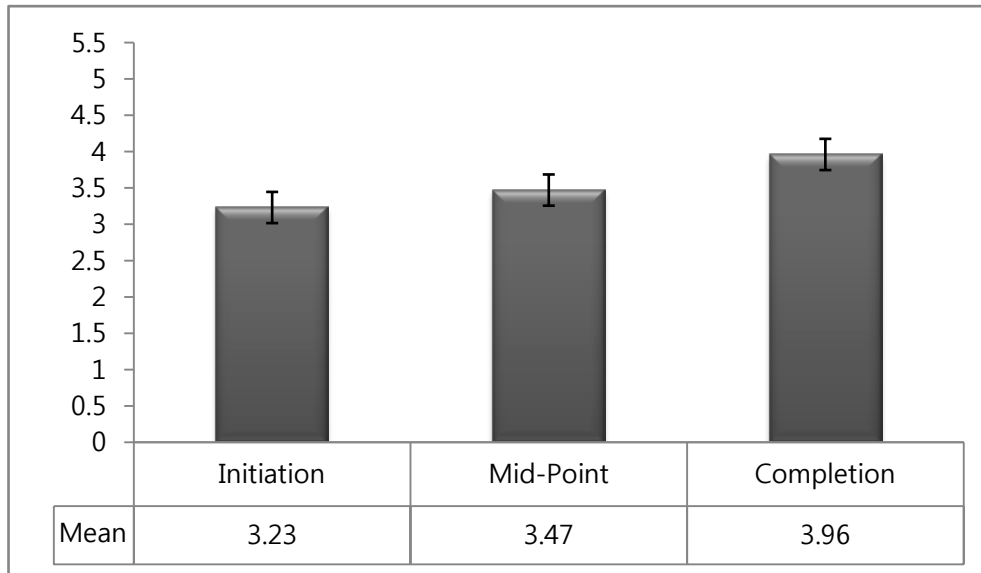
Figure 4.8. Mean changes in perceived familiarity with group members

The result of a one-way ANOVA revealed that there were significant differences in perceived familiarity with other group members during the three stages of the project ($F = 10.437$, $p < .01$).

In addition, the results of a *t*-test indicated that there were significant differences in the perceived the level of students' familiarity with their group members between the mid-point stage and the completion stage and the initiation stage and the mid-point stage.

- Mid-point and Completion ($df = 42$): $t = 3.627$, $p < .01$
- Initiation and Completion ($df = 42$): $t = 7.094$, $p < .01$

Overall, group members became more familiar with other group members as they progressed on the research project. There were no students who indicated that their perceived degree of familiarity was at the lowest level, and reported an average 'moderate' perception of familiarity with group members across group members and processes during the project. This may have affected their information seeking activities associated with the group project.

To find the relationship among group members' information seeking activities and the level of familiarity with their group members during the three stage of the research process, a chi-square test was also analyzed at each stage. The result of the chi-square test indicated that there was a meaningful difference between the group members' information seeking activities and the level of familiarity with their group members at the completion stage of the research project ($\chi^2 = 43.981$, $p < .05$).

When looking at the results of the test, the results showed that group members who perceived a '5) *A great deal*' of familiarity with their group members, selected overall information seeking activities at the completion stage, while students who perceived '4) *Quite a bit*' and '3) *Somewhat*' familiar with their group members were mainly focused on the information seeking activities about "Writing about themes and ideas," and "Rechecking sources for information initially overlooked." This implies that students who perceived a high degree of familiarity with group members generally searched information on the group-based experience in negotiating their topic until the completion point of the project. With reference to Hyldegård's (2009) study, group members' behavior can be influenced by their familiarity with group members, and this connected positively in the way of their knowledge construction, and goal and attitude of information seeking activities. Thus, it seems that social factors affected problem solving on group based information seeking in this study.

99

4.6   Research Question 2: Collaborative Information Seeking Activities

- In which ways do group members have different perceptions of collaboration levels

    throughout the group-based research project?

In this section, group members' perceptions of collaborative levels for their group

members are discussed according to the three points in the process of the assignment. To answer

research question 2, students were asked to respond about how much they interacted with their

group members throughout the three points of their research process.

Regarding the students' perceptions of the collaborative research project, students were

asked to respond how much they interacted with their group members. Five categories of

collaboration levels, which were based on a study by Frey, Logmeier, Lee, Tollefson, and

Johanning (2004), describe for the degree of defined roles, communication, information sharing,

and decision making between group members during their project at each point of process. The

students were asked to choose one response that best describes their situation in the three points

of the behavior survey, and the degree of collaboration is presented as a number from '1)

individually' to '5) *collaboratively*.' As shown in Table 4.8, students exhibited a higher degree of

collaboration with their group members as the research projects progressed.

Table 4.8

Perceived Collaboration Level

How much have you interacted with your group members?	Initiation		Mid-point		Completion	
	N	%	N	%	N	%
1	3	7	1	2.3	0	0
2	11	25.6	8	18.6	2	4.7
3	16	37.2	14	32.6	6	14.0
4	9	20.9	16	37.2	17	39.5
5	4	9.3	4	9.3	18	41.9
Total	43	100	43	100	43	100

Note: 1= low collaboration. 5= high collaboration

The level of students' collaboration with their group members started research with '3) *Somewhat*' collaborate ($M = 3.00$, $SD = 1.069$) and became continuously more collaborative with peers during the whole periods of the research project (Mid-point: $M = 3.33$, $SD = .970$; Completion: $M = 4.19$, $SD = .852$). Figure 4.9 provides the changes of mean and standard deviations in group members' perceptions of collaboration level. This implies that students felt more interactive with their group members as the group-based research project progressed throughout the overall period of the project.

	Initiation	Mid-Point	Completion
■ Mean	3	3.33	4.19
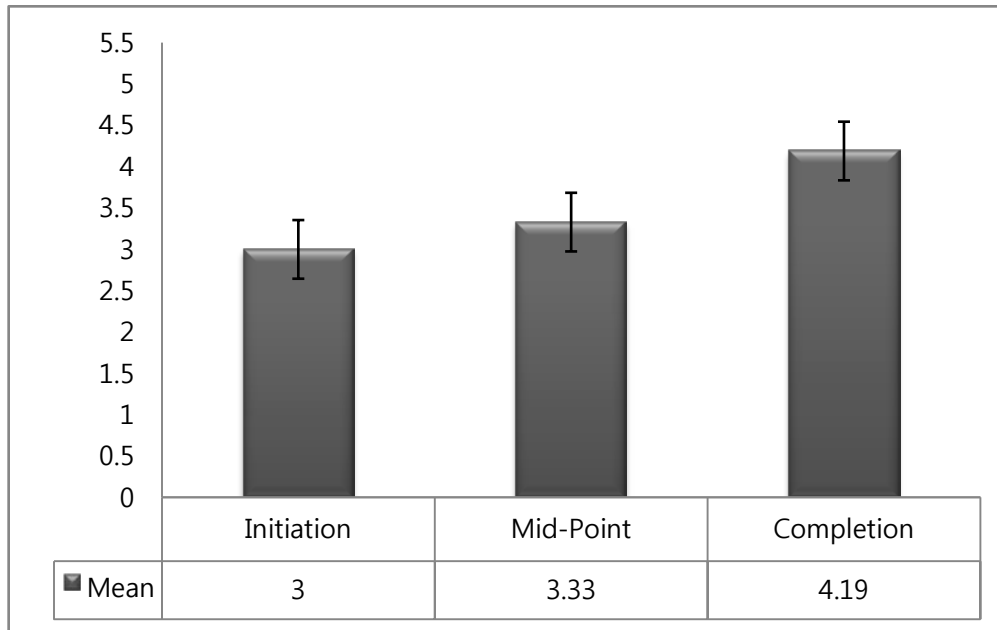
Figure 4.9. Mean changes in perceptions of collaboration level

To assess mean differences among the three stages of the research project, a one-way ANOVA test and a *t*-test were calculated in this section. The results of the one-way ANOVA test indicated that there were statistically significant differences in the perceived degree of collaboration level with group members during the three stages of the research project ($F = 17.249, p < .01$). Also, the results of the *t*-test showed that there were important increases in students' perceptions of collaboration level between the mid-point and completion stage, and the initiation and completion stage.

- Mid-point and Completion ($df = 42$): $t = 4.837, \ p < .01$

- Initiation and Completion ($df = 42$): $t = 5.483, \ p < .01$

The students felt more interaction with their group members as the group-based research project progressed throughout the overall period of the project. They initiated their project with a moderate collaboration level with their group members, and at the completion stage, they

communicated and shared ideas frequently. It would seem that the group-based research project

offered to students in this study prompted a more collaborative approach to information sharing

and seeking with peers. In Yue and He's (2010) study, they found that different levels of

collaboration were presented in different stages of project. Students who were involved in the

group-based search task tended to be initiated with intensive collaboration with group members

for setting up search strategies and exploring information than at the mid-point of the

collaborative work, and the collaboration level changes to an individual basis at the mid-point. In

the final stage, their collaboration level increased again and changed to the collaboration basis to

complete the final project. However, the findings of this study about the collaborative level

during the group-based project were different with the ones in the academic setting. This implies

that the results of collaboration level may vary depending on other environments, such as group

members' cognitive, social factors and context.

4.7   Research Question 2.1: Cognitive Dimension

- How are the cognitive factors related to their perceptions of collaboration levels?

       To find the statistical relationship among group members' perceptions of collaboration

levels, perceived understanding of the topic, and perceived difficulty of the project during the

three stage of research process, a Pearson coefficient correlation was calculated in this section.

Tables 4.9 and 4.10 indicate the correlation coefficients of the three relationships.

Table 4.9

Relationship between Perceived Collaboration Levels and Knowledge of the Topic

Collaboration levels	Perceived knowledge		
	Initiation	Mid-Point	Completion
Initiation	.377*	-	-
Mid-Point	-	.273	-
Completion	-	-	.289

Note: *p < .05. **p < .01

Table 4.10

Relationship between Perceived Collaboration Levels and Difficulty of the Project

Collaboration levels	Difficulty of the topic		
	Initiation	Mid-Point	Completion
Initiation	-.210	-	-
Mid-Point	-	-.049	
Completion	-	-	.351*

Note: *p < .05. **p < .01

First, as mentioned before, there was no relationship between the students' perceived understanding of the topic and their perceived difficulty of the project.

Second, the group members' perceptions of collaboration level were compared to their perceived understanding in their topic at each stage of the research project. A strategically positive relationship was found between students' perceived degrees of collaboration and their perceived understanding in the topic ($r = .377$, $p < .05$) at the initiation stage of the research

project. This positive relationship represents that students who reported a high degree of collaboration with other group members tended to highly perceive their knowledge of the topics as well at the initiation stage of the research project.

Finally, the relationship between the group members' perceptions of collaboration level and their perceived difficulty about their project were statistically significant at the completion stage ($r = .351$, $p < .05$). This correlation revealed that students who reported a high level of difficulty in the project tended to exhibit highly perceived degrees of collaboration.

This implies that students perceived their topics as somewhat difficult at the final stage, and they tended to more frequently communicate and share with other group members to solve the problem as the project progressed. This finding is supported by the findings by Reddy and Jansen (2008). They found that a high level of complexity in information needs generate more collaborative information seeking activities and the use of a higher variety of information sources. Hence, the characteristics of the environment may take place, shifting the group members' information behavior either individually or collaboratively. These findings correspond well to the findings by Yue and He (2010); they stated that when collaborators are sharing information and making decisions together, the tasks are easier to complete in a synchronous environment.

4.8 Research Question 2.2: Social Dimension

- How are the social factors related to their perceptions of collaboration levels?

Pearson's product-moment correlation coefficients were calculated to find the relationship of concern with perceptions of collaboration levels and social factors (familiarity with group members).

The results show that there were positive relationships between group members'
perceptions of collaboration levels and social presence among the overall stages of the group-
based research project (see Table 4.11).

Table 4.11

Relationship between Perceived Collaboration Level and Familiarity with Group Members

Collaboration level	Familiarity		
	Initiation	Mid-Point	Completion
Initiation	0.355*	-	-
Mid-Point	-	0.473**	-
Completion	-	-	0.380*

*Note: *p < .05. **p < .01*

The students who significantly increased their perceptions of intimacy with group
members were more likely to perceive a high degree of collaboration level. This study can
conclude that as they were getting more familiar with group members, their collaboration levels
increased during the entire process of the research project. Thus, as collaborators increased their
faith and became more familiar with group members, it affected to generate more contributions
and information sharing among each other throughout their group-based work. This finding has
also been reported in the study by Yue and He (2010). Based on the analysis of the experiment
results, they present a model showing an increase in being familiar with group members as the
search process moved forward. In addition, So and Brush (2008) stressed that feeling a
connection and intimacy among group members is a critical factor in group-based learning.

Therefore, the social interaction with group members offered inspiration for participation and learning in the group project. Curtis and Lawson (2001) also stressed that social interactions between students encourage their collaborative learning process in an online course. Therefore, the results of this study support Curtis and Lawson's findings about the importance of social communication in online-based collaborative learning. Therefore, the findings of this study imply that there are relationships between the degree of familiarity with group members and their collaboration levels during the group-based research project.

4.9   Research Question 3: Collaborative Problem Solving

- In what ways do group members require collaborations or supports from peers to solve their difficulties or problems throughout the group-based research project?

4.9.1   Behavior Survey

To better understand students' experiences in information seeking during the research project, students were asked to list open-ended items concerning the difficulties or problems they encountered and how they solved the problems with group members. Although students understood their research topics and perceived a high degree of collaboration levels during their research project, they were often faced with difficulties or problems, which made it difficult for them to process the information seeking activities and group work. In this study, it was found that different types of difficulties existed in different stages of the project.

The students were asked to respond the following items during the three points of behavior survey:

107

- *Initiation*: Since the beginning of this group project, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

- *Mid-point*: Since the last process survey, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

- *Completion*: Since the last process survey, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

A total of thirteen categories emerged for the item of what students thought were the most difficult problems and what the essential interventions were, and these are indicated below in order of frequency (see Table 4.12).

At the initiation stage, a total of 14 students (36.8%) reported that their groups worked well together so they did not have any difficulties or problems during their group-based research project from this beginning point.

Some students said:

S22: We did not encounter any problems as such. We just took our time to decide which libraries should we focus on and what direction our project topic should go in by discussing among ourselves.

S24: No problems have been encountered thus far.

S26: So far we have not come across any problems because we are still at the beginning stages of the project.

Table 4.12

Collaboration Problem by Project Stage

Collaboration Problem	Initiation		Mid-Point		Completion	
	Count	%	Count	%	Count	%
Arranging Meeting Time	7	18.4	6	14.3	6	14.6
Communicating with group members	6	15.8	6	14.3	5	12.2
Focusing the topic	2	5.3	1	2.4	2	4.9
Scoping or formulating the project	1	2.6	7	16.7	1	2.4
Using communication technologies (technical problem)	5	13.2	1	2.4	5	12.2
Managing time to work or project	3	7.9	4	9.5	3	7.3
Dividing jobs among group members	3	7.9	3	7.1	4	9.8
Understanding the concept or idea	1	2.9	1	2.4	0	0
Organizing and writing paper	0	.0	3	7.1	7	17.1
Seeking relevant materials	0	.0	1	2.4	1	2.4
Low activities of group members	1	2.6	3	7.1	0	.0
Do not have any problem	14	36.8	13	31.0	12	29.1
Other	0	0	0	.0	1	2.4
Total	43	100	43	100	43	100

However, several students mentioned communication issues with group members apart from the information-related issues. Seven respondents (18.4%) responded that arranging a meeting time with group members as a problem at this stage, and six students (15.8%) mentioned

that they had problems about intra-group communications generally.

Some students commented:

S33: Finding a time when everyone is available. Also, communication is difficult.

S35: It has been really hard to get us together. I think over this week our communication is better. I will continue to work hard with all of our team members.

 S43: Getting everyone to meet at the same time to chat about our topic.

 In addition, three respondents (7.9%) indicated that there were some problems using communication technologies, such as chat rooms or Google Docs, and the same portion of students (7.9%) responded that dividing jobs for group work was a problem at the initiation stage.

For instance:

S09: We have had trouble cleanly dividing our topic into sections we can research individually.

S10: I have had difficulty figuring out how to evenly split up the work load of the project to each member. The topic does not have an obvious split that allows us to share the burden equally.

Surprisingly, a very small number of respondents mentioned the issues of 'focusing the topic.' 'Scoping or formulating the project,' and 'Understanding the topic.' Thus, students seemed to be more focused on the activities of communicating with group members and dividing jobs for their group project at this point. This suggests that students seemed to be more concerned with the activities of communicating with group members and dividing jobs to initiate their group project, so they faced many difficulties about these issues at this point.

At the mid-point stage, the highest proportion of respondents (31%) also reported they

did not have any difficulties with their group-based research project. At this point in the research process, the respondents presented the information-related issues as their difficulty or problems more than in the initiation stage. For example, seven students (16.7%) reported that they had difficulties with scoping or formulating the project.

Some students commented:

S05: With such a big topic, it was difficult for us to narrow it down."

S38: We have been trying to have a sharper focus on issues of user interfaces. We have agreed on the assignment of sections and are beginning the writing process. This is a broad-ranging topic and so the challenges section is especially hard.

In addition, three students (7.1%) mentioned that organizing information and writing the paper was difficult, and two students reported that focusing the topic (2.4%) and seeking relevant material (2.4%) were the difficult at that point.

For example:

S30: One of the problems was organizing the paper and deciding who writes the different parts. After a chat session, we decided what the topic order was and who would write which parts.

S33: Our biggest difficulty right now is in organization.

In addition, the categories of arranging a time to meet with group members (14.3%) and communicating with group members (14.3%) still had the highest percentage of the overall responses.

For instance:

S15: Communication is only a problem that we have encountered. I think we will try to communicate more with every member of the group by using Blackboard and

Wiki.space.

S02: I find this long distance group project to be very difficult, as a concept and in practice. There are other projects that have earlier deadlines and more concrete tasks (ex: [topic 1] Review) it is easy to keep putting this off and focus instead on a project where we actually know what to do. We have tried to communicate but it has been awkward. I do not hold any blame on my teammates. I think we are in the same boat.

At this stage, it is interesting to note that three students reported a complaint regarding their group members' low participation for their group project (7.1%).

They commented:

S03: It seems to me that very little have been done on the project at this point. I have seen very little work or communication; to be fair I was under the weather for a week or more at one point.

In the middle of the research project, this study found that it was challenging for the students to undertake a complicated research project in a group-based setting. So, the students reported that they were faced with more information-related difficulties or problems than in the initiation stage, such as scoping or formulating the project, organizing information and writing the paper. It seems that at the middle of the research project, most students were in the actual information search process based on the individual activity, so they felt difficulties in solving their problems and seeking relevant information related to the topic.

When the group members were working together at the end of the research project, a total of 12 students (29.3%) also mentioned they had worked well with group members without problems or difficulties. At this point, the aim was generally to complete writing the paper;

therefore many students (17.1%) encountered problems with organizing and writing the paper.

Students commented:

S08:   Combining all the writing together is not easy.

S11:   Reorganizing and editing paper is the most difficult part.

S18:   Having trouble getting together to complete the project and finding more

information on certain topics....in order to support the paper.

In addition, to complete the paper together, they had several communication issues, such as using communication technologies (12.2%), arranging a meeting time with group members (14.6%), and communicating with group members (12.2%).

In this study, several students encountered the problem of organizing and writing the paper due to fact that the aim of this point was generally to combine results and complete writing the paper. Therefore, they had several communication issues, such as using communication technologies, arranging meeting times with group members, and communicating with group members for sharing information for the final process.

To solve the difficulties or problems during the group-based research project, students tried to solve them in various ways. When looking at students' collaborative solutions, surprisingly, there were not huge differences in the results among the three stages of the group project. Thus, it seemed that although group members were faced with different problems during the three stages, they tended to solve them independently rather than with other group members.

 Some students commented

 S19:   Did not consult the group to solve my problem.

 S05:   My group members can't help with each other, it is my over extended schedule.

In addition, more than half of the students who responded to the survey item regarding

collaboration problems did not respond to the item regarding collaborative solutions. So, this study obtained a lack of data for this research question since item 5 of the behavior survey was double-barreled. Therefore, more students responded only about problems or responded to problems and solutions together.

A total of seven categories emerged for the item of what students did with their group members to solve the problem, including scheduling meetings on weekends or other times, meeting online using alternative communication tools, dividing sections of the project among group members, depending on the group leader for direction, discussing with group members, working together to find and share information they needed, and asking help to the instructor. These are presented below in order of frequency (see Table 4.13).

When students had technical problems with their communication tools, such as chat rooms and discussion forums in the Blackboard learning management system, or with finding ways or places to work together, each group created their own space for communicating between group members using an alternative tool such as Google Docs or Wiki.space. A total of 7 students (16.3%) at the initiation stage, 5 students (12.0%) at the mid-point stage, and 10 students (23.2%) at the completion reported that they tried to meet with other group members using alternative online communication tools.

Students mentioned that:

S30: The main problem has been with Blackboard's chat feature. I was unable to get into the chat. However, I was able to follow the chat log. I notified another of my group via phone about the problem and I was following the discussion.

S36: Using Google Docs has been really hard to work with. So we are using blackboard and email as a back up. Which has proven to be very successful for our group.

S19: We had a little trouble finding a place to have the meeting, but decided

Google Documents would probably work fine.

S33: We have a Google Docs going where everyone has been contributing their

information, and it's in desperate need of organization! That needs to be our

next task so we can get our drafts written and done.

S43: I think the hardest part is finding ways to work together with our busy lives

and schedules. We decided to try starting a google+ circle so that we can meet and

discuss relevant topics once a week. We are also using google docs to share

progress and any work that we have compiled. I think that this will be a great help.

In order to solve their problems of arranging a meeting time and communicating with group members, many groups tried to schedule to meet on the weekend using chat rooms or asynchronous communication tools to work together any time and any place. A total 2 students (5.1%) at the initiation stage, 8 students (19.0%) at the mid-point stage, and 5 students (12.0%) revealed they rescheduled their group meetings on weekends to communicate with every member of group.

In addition, some students said that focusing the topic and scoping or formulating the project were most challenging. To solve the difficulties, students tried to divide up several sections among group members (5.1% at the initiation and mid-point stage and 2.3% at the completion stage).

Students said:

S05: With such a big topic, it was difficult for us to narrow it down. However, we

worked to divide up certain sections, and that helped the process go more smoothly.

S25: I noticed that my topic and other group members were too similar and overlapped.

With a little communication and brainstorming we were able to fix the problem and

expand our paper to include other important aspects of [topic 3].

Table 4.13

Collaboration Solution by Project Stage

Collaboration Solution	Initiation		Mid-Point		Completion	
	Count	%	Count	%	Count	%
Meeting online using alternative communication tools	7	16.3	5	12.0	10	23.2
Working together with group members to find information as needed	2	5.1	8	19.0	5	12.0
Discussing with group members to solve problem	3	7.1	5	12.0	6	14.1
Dividing sections and jobs of project among group members	2	5.1	3	7.1	5	12.0
Scheduling meetings on weekends or different times	3	7.1	1	2.3	3	7.1
Depending on group leader for direction	3	7.1	4	9.5	3	7.1
Dividing jobs among group members	2	5.1	2	5.1	1	2.3
Other (asking help to instructor)	0	0	0	0	1	2.3
None	21	49.0	15	35.0	34	79.0
Total	43	100	43	100	43	100

In addition, when they experienced some difficulties with the project, they tried to solve

the problems and expand their project by discussing it with other group members and working

together to find the information they needed. The overall response rates of these two solutions

were higher than other categories during the three stages of the research project.

For instance:

S09: By discussing at each meeting our current thoughts on the divisions and how they overlap, we are staying flexible about our respective responsibilities.

S16: We are working together to help further define, outline, and find information for this section of the paper.

S12: Everyone has been communicative and discussed about what they have been doing, and things have gone rather smoothly!

It was interesting to note that when students had some problems with their group project, they tended to depend on their group leader in each group to decide any appropriate solution and solve the problem rather than the instructor or a class assistant. The group leader made a number of contributions such as organizing group work, initiating activities, and assisting other group members.

For example:

S34: My biggest difficulty to date is a lack of direction from the team leader. Totally not sure what she wants. I am shooting in the dark and hoping for the best.

S37: We had difficulty deciding on potential focus points for our paper, so we all determined to look at case studies to find out what issues are currently relevant to user interface design and management. Also, we all had a little difficulty deciding who would write what portions of the paper because we were all being too polite (Well, you can write the section you like best and I will take the other section; It doesn't matter to me - you pick the one you like best! etc.).Our group leader decided to assign each of us a section to solve this problem.

117

When looking at the findings of their problems and solutions in the collaborative work, these are similar to the findings by Yue and He (2010). In their CIB model, they presented the different types of supports needed at each stage of the search process. At the initial stage, when the communication and awareness were well supported, the students found it easier to begin the search task. In the following stage, they needed help such as collaborator's recommendations and support for relevancy judgment. In the final stage, they wanted collaboration support like a shared space for gathering results to complete the task.

Further, the findings on the communication tools showed that several students also used them to work out the difficulties or problems which occurred during their group project. Therefore, the synchronous and asynchronous media affected their collaboration process in the online collaborative learning environment. In the contents of the group communications, a similar tendency was seen as with the responses on the behavior surveys. In Reddy and Jansen's (2008) study for CIB, they discussed that there are three triggers for arousing collaborative information behavior in the groups. Originally, the concept of trigger has been used by Orton, Marcella and Baxter (2000) to explain individuals' information seeking behavior in a parliament team. They claimed that the diverse triggers initiate the members on an information seeking behavior. In the collaborative information seeking process, Reddy and Jansen found that the triggers include not only the complexity of the information need but also a lack of access to needed information and a lack of domain expertise. When group members were confronted with the problems in their research process, they tended to engage in collaboration to solve them. In this case, students showed a similar tendency with Reddy and Jansen's study. When a group member does not have prior knowledge about his topics, he did turn to other group members to get their assistance. Also, when the group members had a problem to find and access the needed

information, they often worked together with their group members to find the information more easily. Thus, they demonstrated a tendency to show more collaborative information seeking activities when they had a higher information complexity need. In addition, they needed more communications and interactions with a number of people and information systems to solve the complex problem.

4.9.2   Online Communication Texts

Several students used communication media to solve difficulties or problems during their group project. Therefore, the synchronous and asynchronous media affected their collaboration process in the online collaborative learning environment. In the contents of the group communications, a similar tendency was seen with the responses on the behavior survey.

Group members basically had difficulty in performing a complex group-based research process. Most students were greatly challenged with focusing on and scoping the project and followed up with each other by communicating with other group members.

For example:

Group 1:

- Overall I'm worried that we're going to have too much overlap between all of the sections and that we won't have enough content/word count. Any ideas about how we can fix these?

- I am having a rough time figuring out section 4. Not sure these articles are really about implementation - they seem more about studies and case studies...I'm confused. One of the articles isn't really even about a [topic 2] it is about a regular old OPAC with a customized interface. Any ideas? Time for my doctor appointment. Will check in later

and brainstorm in my brains.

Group 6:

- I am confused about the meaning and implication for [topic 5] part within the background.

- It's ok. It's a little confusing. I think that is a way of saying, how are [topic 4] relevant to [topic 4] I don't mind doing both, unless yall want one. I think one of the implications is, [topic 4] are usually a big part of [topic 2]. So that means, these challenges we are talking about are really really important for [topic 4] to consider.

- That makes sense.

Group 7:

- Well I'm afraid mine's becoming too broad. I haven't posted anything cuz right now I just have pages and pages of notes. I 'm a little lost on how to organize. But there's no way I could do an entire section just dreaming about what the future holds.
So I'm all over the place. I have stuff on privacy, recommendation (because that is going to continue to be a big part of personalization in [topic 4]), examples of collaboration overseas (IFLA, Italy)."

Group 5:

- Here are some articles that I found as part of my interest in digitization and [topic 4]. I don't know if they are too broad to cover our topic, but I thought they were interesting enough to at least mention as a dimension of digitization."

In addition, many students had difficulty in organizing and writing the paper in order to complete the research project. In particular, students reported difficulties in formatting the paper and checking cited references at the final point of the project.

For instance:

Group 5:

- I'm having a really difficult time focusing on and writing my section of the paper, but I will have it sent by 5. Setting deadlines for myself and sticking to them is something I'm just having to learn as a grad student, so I apologize for my lateness.

- I will remove the page numbers and re-attach my portion when I get home to my laptop. Thanks for catching that! I am always messing up with the APA style... I will talk to you all later tonight.

- Oh, okay. I never ran across that in my years of writing APA papers and have never gotten marked down for not including page numbers. Sorry for the mistake!

Various technical problems with the communication tools were also presented in the students' discourses.

For example:

Group10:

- I am having technical problems getting into the chat room. I am therefore following the log.

- Yeah, the chat function does not work as well as the Wimba classroom for sure.

4.10   Summary

There were many deviations in the group members' information seeking behavior and that various cognitive and group processes affected their information seeking activities. This was further examined though answering the research questions. For Research Question 1: "In which ways do group members exhibit information seeking activities throughout the group-based

research project?; how are the cognitive factors related to group members' information seeking activities throughout the group-based research project?; how are the social factors related to group members' information seeking activities throughout the group-based research project?" this study found that the group members' information search activities decreased as the project progressed, while the activities of checking information found and writing the paper increased as the project progressed. When comparing group members' general information seeking behavior with Kuhlthau's ISP model, their information seeking activities were in line with her model. However, in this study, some students tended to not follow only one direction of the stages in the ISP model. Circles occurred among the six stages of the ISP model when they had not completely reached certain steps in the information search process. Further, the results of the study found that group members' information seeking activities were significantly related to the cognitive factors, including perceived understanding of their topic and difficulty of their project. In addition, group members' familiarity with group members was significantly related to their group-based information seeking activities in the ISP model. Overall, the results of this study showed that the ISP model was useful in understanding the information seeking activities of graduate students who are engaged in a group-based research project.

Second, this study explored the relationships among group members' perceptions of collaboration levels, perceived knowledge of their topic and perceived difficulty of their project, and perceived familiarity with group members to answer Research Question 2: "In which ways do group members have different perceptions of collaboration levels throughout the group-based research project? ; how are the cognitive factors related to their perceptions of collaboration levels?; and how are the social factors related to their perceptions of collaboration levels?" this study explored the relationships among group members' perceptions of collaboration levels,

perceived knowledge of their topic and perceived difficulty of their project, and perceived familiarity with group members. This study found that students, who participated in a group-based project, seemed to be involved the project independently at the initiation stage, but worked together more frequently with other group members as the project progressed. This study also found that there were positive relationships between students' perceived degrees of collaboration and their perceived understanding of the topic at the completion stage of the project, and their perceived degrees of collaboration and difficulty about their project at the initiation stage. In addition, the relationship between group members' perceptions of collaboration levels and social presence (familiarity with group members) was positive during the overall stages of the project.

Finally, for Research Question 3: "In what ways do group members require collaborations or supports from peers to solve their difficulties or problems throughout the group-based research project?" this study found that a total of 13 categories emerged for the item of what the students thought were the most difficult problems and essential interventions. Group members expressed different difficulties at each stage of the research process. Surprisingly, there were not any huge differences among the three stages. For example, they mainly had problems with communicating with group members at the beginning, and at the mid-point most of them had difficulty in scoping and focusing on the topic. At the completion stage, they had trouble with sharing the information that was found throughout their research project. In addition, this study found that a total of seven categories emerged in regards to the research question of what students did with their group members to solve the problem. There were also not large variances in the results between the three stages of the group project. Thus, it seemed that although group members were faced with different problems in the three stages of the project, they tended to solve them as individuals rather than with other group members. In addition, many students did

123

not respond to this item, so this study obtained a lack of data for this research question since item 5 of the behavior survey was double-barreled. More students responded only about problems or responded to problems and solutions together.

CHAPTER 5

CONCLUSIONS

5.1   Introduction

This study explored graduate students' information seeking and use when involved in

collaborative learning and identified the factors related to that process over time. There were

considerable differences in information seeking behaviors in collaborative learning according to

different kinds of factors. In addition, this study needed to analyze students' communication in

their group work by categorizing the content of the communication messages exchanged during

group activities, since active interactions are required during group work to have successful

group collaborations (Alavi and Dufner, 2005). In this chapter, the exploration of group members'

information seeking process in a learning environment will contribute understanding and verify

research, theory, and practice in the field of information behavior as well as related areas. In

particular, the results of this study will contribute to the expansion and further development of

Kuhlthau's ISP model and Yue and He's CIB model through the development of graduate

students' collaborative information seeking behavior in an academic setting. Furthermore, it

suggests other implications for researchers, information professionals, and instructors working in

learning environments, including library and information science (LIS) for higher education and

Information Behavior.

5.2   Key Findings

The participants of the study were 43 graduate students from a course: 35 were female

(81.4%) and 8 were male (18.6). They were in 13 groups and each group was assigned to a topic

among six research topics.

First, regarding group members' information seeking activities in the ISP model throughout the group-based research project, the relationships between cognitive factors and their information activities and between social factors and their information activities, this study found that the group members' information search activities decreased as the project progressed, while the activities of verifying information found and writing the final paper increased as the project progressed. When comparing group members' general information seeking behavior with Kuhlthau's ISP model, their information activities were in line with her model. Further, the results of this study showed that group members' information seeking activities were significantly related to the cognitive factors, including perceived understanding of the topic and perceived complexity of the topic. In addition, group members' familiarity with other group members was significantly related to their group-based information seeking activities in the ISP model.

Second, regarding the relationships among group members' perceptions of collaboration levels, estimated knowledge and difficulty of their topic, and perceived familiarity with group members, the results presented that there were positive relationships between students' perceived degrees of collaboration between group members and their estimated understanding of the topic at the completion stage of the project and their perceived degrees of collaboration and complexity about their topic at the initiation stage. In addition, the relationship between group members' perceptions of collaboration levels and social presence was positive among the overall stages of the project.

Finally, for the research question about collaborative problems and solutions throughout the group-based research project, the results revealed that a total of thirteen categories emerged

126

for the question of what the students thought were the most difficult problems and essential interventions. Group members expressed different difficulties at each stage of the research process. In addition, a total of seven categories emerged in regards to the research question of what students did with their group members to solve the problem. There were also not large variances in the results between the three stages of the group project.

5.3   Theoretical Implications

This study applies Kuhlthau's ISP model and Yue and He's CIB model to explain graduate students' information seeking behavior in a collaborative learning environment throughout three stages of a research process. The results of this study provided a deeper understanding of group members' information seeking and use through the three stages of the group-based research project, as compared to earlier presented models on information seeking behavior. At the theoretical level, this research contributes to these models by adding group effort and learning dimensions in higher education as potential elements which influence human information seeking behavior.

5.3.1   Group Members' Information Seeking Behavior in the ISP Model

Since it was developed in the early1990s, the ISP model has been validated and generalized with a large number of studies in various contexts in order to examine an individual's information search process and behavior. In particular, this model was initially conducted to describe the information behavior of high school students, and it plays an important function in leading investigative research studies for students' information behavior in their learning environment. However, there is little literature about students' information processes in a

collaborative learning environment, especially in higher education (Hyldegård, 2006, 2009). The results of current study presented how graduate students experience information seeking and use through a group-based research process. It showed what factors interact with group members' patterns in their information seeking and use. Therefore, the theoretical contribution of this study is to advance the ISP model that describes graduate students' collaborative information seeking and use in learning environments.

As addressed in Chapter 4, there were similarities between group members' information seeking behaviors and the information seeking process in the Kuhlthau's ISP model. Their information seeking process tracked the general stages of information seeking behavior in the ISP model. The students in collaborative information seeking presented that their information search activities decreased, while the activities of checking information found and writing the paper increased as the project progressed. In addition, some students tended to not follow only one direction of the stages of the ISP model. Circles occurred among the six stages of the ISP model, and several students returned to the previous steps for more information searching when they had not completely identified with the topics. The results were in accord with Kuhlthau's (2004) study. There were many variations from the ISP model, and this suggests that various cognitive, social, and group processes affect group members' information seeking activities in the research project.

5.3.2   Group Members' Information Seeking Behavior in the CIB Model

To explain group members' collaborative information seeking and use, and which factors affect their experience in collaborative work, this study was outlined in Yue and He's CIB model. The model explains that there are different stages of CIB, collaboration levels, difficulty of task,

and types of supports needed for solving problems in collaborative information seeking. Also, the model describes the cognitive load of the group member in the search process, which is reflected as getting familiar with other group members. As discussed in Chapter 2, there have been constructed not only a few studies on collaborative information seeking, but Yue and He's CIB model has not been validated in various contexts. In this sense, this study represented an attempt to develop the CIB model in order to bridge a gap in the field of collaborative information behavior, especially in the learning context.

Based on the findings of the group members' information seeking process at the initiation, in the middle, and at the completion of the research project, they demonstrated similar experiences in perceptions of difficulty of the project, types of supports needed, and cognitive load as those presented in the CIB model. First, group members' perceptions of difficulty of their project were found to increase toward the mid-point of the research project, and then they had a perceived less difficulty at the end of the project with gathering information and writing activities since they had reached a finishing point on searching information. Second, as described in the CIB model, the group members wanted similar supports during the process of the research project; they generally needed support for frequent communication among group members at the beginning, and at the mid-point, most students were in the actual information search process based on the individual activity, so they felt difficulties in solving their problems and seeking relevant information related with the topic. At the completion stage, they called for shared space for gathering information found to complete their project. Finally, the results of perceived familiarity with group members increased as the project progressed, and that was a similar pattern as was revealed in the model. However, group members did not perceive similar experiences in the perceptions of collaboration level as the group members provided in the model;

at the middle of the project, they perceived their collaboration level as higher than the initiation stage and their perception of collaboration level increased toward the completion stage, which was different with the results in the CIB model. This implies that when they participated in the actual information search process and writing the paper, collaboration played more important roles in this study, and it can vary based on the group members' work style and context of work.

Throughout the entire study, the CIB model provided a direction to identify a framework and a problem of this study. The results of this study will contribute to elaboration and further development of the CIB model of graduate student's collaborative information seeking in a learning context. By applying the CIB model in this academic setting, it will lead to implications for academic settings at different levels or other various contexts.

5.4   Practical Implications

The findings of this study will contribute understanding of efficient information strategies, instructional interventions, and information systems to support collaborative learning in higher education. Hence, the practical contributions of this study help identify awareness among instructors and academic librarians about how graduate students work on group-based research projects and the difficulties they may meet.

The results of this study showed that group members had difficulty in performing their research process during various steps of the information process. For example, they needed to find background knowledge, to scope the research project and to ask someone who knows about the project. According to Kuhlthau (2004), the acts of a librarian or a peer as a collaborator help students' difficulties or problems in the information search process. Through interventions between librarians, instructors, or peers, students are able to minimize the problems and

accomplish their information tasks successfully. Also, the interventions should be constructed by the type of content. In this study, the information seeking behavior is regarded as a part of students' learning process. So, in order to help to reduce the students' difficulties in their group-based research project, not only group members in the group but also instructors and academic librarians should try to implement the research project with the topic and acknowledge their specific needs for their group-based projects. Thus, instructors and information professionals, who working with students in research, should be able to more adequately meet their needs on collaboration by assisting with more diverse and professional information services and resources - i.e., students' learning, information seeking and use, and information literacy. Likewise, they should construct more careful and useful interventions to provide guidance concerning group-based issues. For example, when students are faced with difficulties or problems during their collaboration, it is desirable for instructors and information professionals to support not only the seeking and using of information but also the sharing of information between collaborators. As shown in the results of this study, students presented different difficulties at each stage of the research process. For that reason, the instructor and information professionals should recognize the challenge for students to undertake a research project in each part of the process and be cognizant of which information technology and resources are appropriate to support students efficiently.

Furthermore, this study would be helpful for system designers in order to develop and evaluate the best supportive collaborative information seeking tools since the medium plays a significant role in students' interactions in their collaborative learning and whole collaborative information seeking process for their research project. The students in this study undertook their course online using the Blackboard learning management system, which provides various

communication tools such as email, discussion boards, and chat rooms. Further, the students used other web-based systems for their communications. The communication tools should be able to facilitate either synchronous or asynchronous exchange not only of information found and but also search logs. Also, the tools must be designed to enable users' different information needs in each process of information seeking activities and have a variety of functions to allow the interface design for group members' collaboration.

Recently, various tools have been developed to help users in their information seeking activities to support collaborative information seeking in learning environments. For instance, Morris and Horvitz (2007) developed 'SearchTogether' which facilities three features for supporting users' collaborative information behavior while searching on the Web, i.e, awareness, division of labor, and persistence. Twidale, Nichols, and Paice (1995) designed 'Ariadne' to help enhance database browsing skills in collaborative learning. In a similar way, Pickens, Golovchinsky, Shah, Qvarfordt, and Back (2008) developed 'Cerchiamo,' which has the capability of a system for asynchronously gathering, retrieving and displaying information from multiple searchers. These tools help teams find more relevant documents by working together. However, these have not yet become popularized in practical use. In addition, this study found that a majority of students in this study revealed they had difficulties with usage of the given communication tools in the Blackboard learning management system, and they used open-source software, such as Google Docs and Wikispaces for group communication. It seems that those free applications are easier to use for students' collaboration than the given media for the course. Therefore, the communication tools for group work should require the features that not only let collaborators seek, collect, save, present, and share their search process easily, but also work together effectively to easily utilize and access information. In addition, instructors should

support their students to use communication tools effectively for their group work.

5.5   Methodological Implications

   This study also presents methodological implications related to the Student Learning through Inquiry Measure (SLIM) toolkit. The toolkit was developed by Todd, Kuhlthau, and Heinstrom (2005), as an assessment instrument for inquiry learning, in order to follow changes in their information seeking behavior and to measure students' perceived knowledge, perceived difficulty, and satisfaction at each stage of the project. Few research studies have investigated students' information seeking behavior in individual learning (Kuhlthau, Heinstrom, & Todd, 2008; Todd, 2006; Todd & Heinstrom, 2006) and group-based learning (Kim & Lee, 2012a, 2012b) based on the research tool. Todd, Kuhlthau, and Heinstrom (2005) emphasized that students can be influenced from inquiry-based learning, and it provides benefits to the learners to engage in more active learning with diverse sources of information and ideas to develop their new understanding and perspectives.

   The primary methodological contributions of this study include applying the newly modified behavior survey based on the SLIM toolkit with graduate students in a collaborative learning setting. In the pilot study, although the application of the SLIM toolkit method seemed to be a useful research tool for the observation of students' information seeking behaviors in a group-based learning setting and resulted in the valuable acquisition of data, the reflective journals based on the questions in the SLIM toolkit proved to be problematic for collecting detailed descriptions from the students. Through the reflective journals, each student was asked to respond the progress of his or her own information behavior and learning at the three stages of the group project. However, since the toolkit was developed to measure changes in individuals'

133

information seeking behavior, there was difficulty in capturing the behavioral differences among the stages of the group projects via the journals. Also, the participants did not provide detailed responses and descriptions for each question in the journals, so it was difficult to track changes in their information seeking activities at each stage. Therefore, it was determined that the reflective journals attempted in the pilot study would not be sufficient for the purpose of the main study, so the journal was replaced by the behavior survey with both open- and closed-ended items to observe the students' behavioral differences between each stage of the research project in the collaborative setting. Also, the researcher made some changes to the survey items in order to clarify how different social and cognitive factors influenced their information seeking and use behavior. The items in the pilot study survey were all open-ended, including estimated knowledge of the topic and difficulty of the research project during the three stages of research project, which were replaced by closed-ended items in the final survey.

As explained in the results of this study, the application of the SLIM toolkit with graduate students in a collaborative learning setting resulted in acquiring unique and significant data in this study. Thus, this research successfully collected data on collaborative information behavior in the online learning environment using the behavior survey based on the SLIM toolkit. The participants reported quality responses in their information behavior survey in regards to their experiences with other group members in their group work. Therefore, this study provides methodological implications for conducting behavior surveys in collaborative learning settings based on the toolkit. Further, the SLIM toolkit can be used in various settings, including in a diversity of curriculum subjects and education levels. In addition, the open-ended items in the behavior survey, including students' collaboration problems and solutions, were analyzed by content analysis. The coding schemes were originated from this study. Therefore, the original

inductive coding schemes for content analysis are also an important contribution of this study as a methodological aspect since there has been the lack of measures of collaborative information seeking in education area. Therefore, such schemes provide potential factors as measures for future study.

5.6   Limitations

Due to the fact that this study was conducted in an academic context, specifically the field of LIS, the results cannot be generalized to non-academic contexts or to different disciplines. Generally, students in LIS may have higher levels of information literacy skills and be better acquainted with the information seeking process than students in other disciplines. This may have affected their information seeking activities and perceptions of group work.

Three additional aspects of the research environment may have influenced the results. First, this study relied on synchronous and asynchronous computer-mediated communication tools in the Blackboard learning management system to indirectly observe students' behaviors during the group-based project. The online interactions allowed observations of information seeking activities, including group members' experiences and thoughts, which could not be obtained through the survey method. However, most online collaborations among group members occurred using other web-based applications, such as Google Docs and Wikispaces. Students usually used the communication applications in the Blackboard learning management system as a tool for setting an appointment in other applications or for dividing individual work; thus most postings were off-topic discussions. Also, they used additional external media, such as cell phones, face-to-face visits, and email, to communicate with each other, and these communications could not be tracked and recorded. These factors reduced the amount of raw

135

data. Therefore, there was no sense in comparing differences in the number of postings among the groups.

Second, the behavior survey was scheduled to be employed three times during the group-based project. Since there was a deadline to complete the survey for each stage, many students did not complete the survey all three times. In order to obtain a whole series of the surveys, all students would have had to complete the surveys during all three stages.

Third, the only open-ended item in the behavior survey asked students to respond difficulties or problems they encountered and how they solved the problems with group members. Because this item was double-barreled, many students responded only about problems or responded to problems and solutions together. This limited the amount of data collected about collaborative solutions.

5.7   Summary

Though research on collaborative aspects of information behavior has increased during the last decade, much more research on the nature of this area is needed. This is because very little is known regarding collaborative information seeking behavior in academic settings (e.g., Hyldegård, 2006, 2009; O'Farrell and Bates, 2009). Therefore, it is hard to predict collaborative information seeking behavior. In particular, research on students' actual information seeking in collaboration has rarely been implemented in the context of collaborative information seeking behavior.

This study explored what graduate students experienced and how they exhibited information seeking activities in the ISP model during a research project and what factors influenced their information seeking activities and perceptions of collaboration levels. In

addition, it looked at what difficulties or problems they encountered during the group-based research project. The results of this study showed that although group members exhibited variations in their information seeking activities during the group-based research project, their information seeking activities were generally in line with the Kuhlthau's ISP model. The variations were influenced by the students' perceptions about perceived knowledge and difficulty of their research project and familiarity with group members. Thus, the variation of group members' information seeking and use interacts with differences in students' perceptions of knowledge of their topic and difficulty of their project, and familiarity with group members. Besides, the students' perceptions about collaboration levels were affected by cognitive and social factors. When they had a high degree of cognitive and social factors, they perceived they were in a high level of collaboration. Furthermore, although students' perceived collaboration levels increased as the research progressed; they also were faced with difficulties associated with the information seeking process in the group project. Their difficulties were caused from communicating with group members, scoping and focusing on the topic, and sharing information found throughout their research project.

The findings of this study contribute to the understanding of the process of graduate students' information seeking activities and their collaboration level in the group-based research process and the influences on cognitive and social factors. Throughout the group-based information seeking process, this study found that group members have different needs according to each stage of the research project and on the characteristics of each group member, including their understanding and difficulty of the project and familiarity with group members. Further, this study demonstrates the call for research on collaborative information seeking behavior to consider not only the assigned research process, but also group members' characteristics and

137

environments, such as information systems and supports from instructors or librarians. Therefore, at a theoretical level, this study contributes to the context of information search process on collaborative learning to Kuhlthau's ISP model and to developing Yue and He's CIB model by identifying how cognitive and social factors influenced collaborative information seeking behavior. As for the practical implications, the findings of this study recommend effective instructional interventions for students' collaborative learning and useful design of information systems for collaborative information behavior. In addition, this study contributes to methodological implications by using the SLIM toolkit in a group-based learning environment.

In conclusion, this study indicated an empirical foundation for the development of library and information services and information systems for collaborative information seeking activities in higher education. The next step is to provide necessary services and tools for supporting the right level of information services for each interaction or situation in the given collaborative information seeking activities and learning. Related to this, future studies can further investigate intra-group members' differences in information seeking behaviors during each stage of the research process and how the cognitive and social factors affect each group's information behavior and collaboration level. In addition, Yue and He's CIB model was newly extended with the learning context in this study, and therefore future research can further explore it in various learning environments, such as different assigned research topics, group membership and information systems to verify its worth and explanatory power. Thus, this study needs to continuously develop and improve the existing CIB models. Furthermore, the current study was based on the research methods of a behavior survey and online communication texts. However, to extend these findings, future studies should be explored by the qualitative method, including interviews and/or observations to obtain deeper and richer data. In addition, this study explored

geographically dispersed groups, which is an online learning setting, which means that there were different situations and information seeking behaviors among group members than in a traditional setting (i.e., face-to-face class). Therefore, in future studies, we need to further investigate how collaborative information seeking activities take place in the online setting and how the activities differ compared to the traditional setting.

APPENDIX A

IRB (INSTITUTIONAL REVIEW BOARD)

Informed Consent Form

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: Graduate Students' Collaborative Information Seeking in a Group-Based Learning Environment

Principal Investigator: Jisu Lee, doctoral student, Interdisciplinary Information Science Ph. D. program, College of Information, University of North Texas (Supervising Investigator: Jeonghyun Kim)

Purpose of the study: The goal of the study is to understand information seeking and its use with graduate students while they participate in a collaborative project.

Procedures:
As a part of your [course #] group project assignment, you were asked to complete a process survey at three points during your group project. Also, you were offered the use of synchronous chat rooms and discussion forums during your group project to communicate with group members. Your response to a process survey and your communication in the chat rooms and discussion forums will stand alone as class assignments and activities should you choose to opt out of the research study. By signing the form below, you are giving your permission to have your responses to process surveys; chat room logs that recorded your discussions with your group members; and messages you posted on the group project discussion forum included in the data for this research study.

Potential Risks and Benefits:
There are no anticipated risks involved with this study. Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course. In addition, there is no compensation for participating in the study, and you will not receive any direct benefits for taking part in this study; however, your answers and work may contribute to learning more about the collaborative information seeking process and its use with graduate students.

Confidentiality:
If you consent to having your surveys, synchronous chat logs, and messages posted on discussion forums included in the data analysis of this study, a code number will be assigned to each data. This will prevent research investigators from matching your process surveys with your personal information.
The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the study:

If you have any questions about the study, you may contact Jisu Lee at Jisulee@my.unt.edu or Jeonghyun Kim at Jeonghyun.Kim@unt.edu.

Review for the protection of participants:

This research study has been reviewed and approved by the UNT Institutional Review Board (Application No. 12-078). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants' Rights:

Your printed name below indicates that you have read or have had read to you all the information above and that you confirm all the following:

• You understand the purpose of the study.

• You understand the possible benefits and the potential risks and/or discomforts of the study.

• You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits.

• The study personnel may choose to stop your participation at any time.

• Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in the course.

• You understand why the study is being conducted and how it will be performed.

• You understand your rights as a research participant and you voluntarily consent to participate in this study.

Printed Name of Participants:

Today's Date:

	MM	DD	YYYY
MM/DD/YEAR	☐ /	☐ /	☐

Your selection of "I do consent" below represents your signature:

◯ I do consent

◯ I do not consent

Done

APPENDIX B

BACKGROUND SURVEY

1. What is your gender?

    1) Male   2) Female

2. What is level of study?

    1) Master's degree   2) Doctorate degree

3. Have you participated in any group assignment before?

    1) Yes   2) No

4. If yes, how would you feel your previous group work experience?

    1) Very Negative   2) Negative   3) Neutral   4) Positive   5) Very Positive

APPENDIX C

BEHAVIOR SURVEY

(Stage I)

1. At this time, how well do you understand the topic of your group project?
   1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

2. At this time, how difficult do you think your group project is?
   1) Very easy 2) Easy 3) Moderate 4) Difficult 5) Very difficult

3. At this time, how intimate and familiar are you with your group members?
   1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

4. Since the beginning of this group project, what have been your tasks for the project?
   [Check as many that apply]

   1) Discussing the topic or information needed with group members.
   2) Formulate questions based on the information needed
   3) Identify key concepts and terms that explain the information needed.
   4) Explore general information sources to increase familiarity with the topic in a variety of formats (e.g., database, website, books).
   5) Intentionally seeking possible focuses and locating relevant information.
   6) Reading information found to learn about the topic.
   7) Outlining to organize information.
   8) Formulating a focus from the information encountered.
   9) Gathering information that defines, extends, and supports the focus.
   10) Writing about themes and ideas.
   11) Rechecking sources for information initially overlooked.
   12) Other_____

5. Since the beginning of this group project, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

6. Since the beginning of this group project, how much have you interacted with your group members? Please choose one answer that best describes your situation.

1 (low)	2	3	4	5 (high)
-Loosely defined roles -Little communication -All decisions are made independently	-Somewhat defined roles -Formal communication -All decisions are made independently	-Share information and resources -Defined roles -Frequent communication -Some shared decision making	-Share ideas -Share resources -Frequent and prioritized communication -All members have a vote in decision making	-Members belong to one system -Frequent communication -Consensus is reached on all decisions

(Stage II)

1. At this time, how well do you understand the topic of your group project?
   1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

2. At this time, how difficult do you think your group project is?
   1) Very easy 2) Easy 3) Moderate 4) Difficult 5) Very difficult

3. At this time, how intimate and familiar are you with your group members?
   1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

4. Since the last process survey, what have been your tasks for the project? [Check as many that apply]

   1) Discussing the topic or information needed with group members.
   2) Formulate questions based on the information needed
   3) Identify key concepts and terms that explain the information needed.
   4) Explore general information sources to increase familiarity with the topic in a variety of formats (e.g., database, website, books).
   5) Intentionally seeking possible focuses and locating relevant information.
   6) Reading information found to learn about the topic.
   7) Outlining to organize information.
   8) Formulating a focus from the information encountered.
   9) Gathering information that defines, extends, and supports the focus.
   10) Writing about themes and ideas.
   11) Rechecking sources for information initially overlooked.
   12) Other_____

5. Since the last process survey, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

148

6. Since the last process survey, how much have you interacted with your group members? Please choose one answer that best describes your situation.

1 (low)	2	3	4	5 (high)
-Loosely defined roles -Little communication -All decisions are made independently	-Somewhat defined roles -Formal communication -All decisions are made independently	-Share information and resources -Defined roles -Frequent communication -Some shared decision making	-Share ideas -Share resources -Frequent and prioritized communication -All members have a vote in decision making	-Members belong to one system -Frequent communication -Consensus is reached on all decisions

(Stage III)

1. At this time, how well do you understand the topic of your group project?
    1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

2. At this time, how difficult do you think your group project is?
    1) Very easy 2) Easy 3) Moderate 4) Difficult 5) Very difficult

3. At this time, how intimate and familiar are you with your group members?
    1) Not at all 2) A little bit 3) Somewhat 4) Quite a bit 5) A lot

4. Since the last process survey, what have been your tasks for the project? [Check as many that apply]

    1) Discussing the topic or information needed with group members.
    2) Formulate questions based on the information needed
    3) Identify key concepts and terms that explain the information needed.
    4) Explore general information sources to increase familiarity with the topic in a variety of formats (e.g., database, website, books).
    5) Intentionally seeking possible focuses and locating relevant information.
    6) Reading information found to learn about the topic.
    7) Outlining to organize information.
    8) Formulating a focus from the information encountered.
    9) Gathering information that defines, extends, and supports the focus.
    10) Writing about themes and ideas.
    11) Rechecking sources for information initially overlooked.
    12) Other_____

5. Since the last process survey, what difficulties or problems have you encountered? And what did you do with your group members to solve the problems?

6. Since the last process survey, how much have you interacted with your group members? Please choose one answer that best describes your situation.

1 (low)	2	3	4	5 (high)
-Loosely defined roles -Little communication -All decisions are made independently	-Somewhat defined roles -Formal communication -All decisions are made independently	-Share information and resources -Defined roles -Frequent communication -Some shared decision making	-Share ideas -Share resources -Frequent and prioritized communication -All members have a vote in decision making	-Members belong to one system -Frequent communication -Consensus is reached on all decisions

REFERENCES

Alavi, M., & Dufner, D. (2005). Technology-mediated collaborative learning: A research

  prospective. In S.R. Hiltz, & R. Goldman (Ed.), *Learning together online:*

  Research synchronous learning networks (pp. 191-213). Mahwah, NJ: Erlbaum.

Allen, T. J. (1977). *Managing the flow of technology: Technology transfer and the*

  dissemination of technological information within the R&D organization. Cambridge,

  MA: MIT Press.

Baeza-Yates, R., & Pino, J. A. (2006). Towards formal evaluation of collaborative work.

  Information Research, *11*(4), 271. Retrieved from

  http://InformationR.net/ir/114/paper271.html

Bilal, D. (2002). Children's use of the Yahooligans! Web search engine: III. Cognitive and

  physical behaviors on fully self-generated search tasks. *Journal of the American Society*

  for Information Science and Technology, *53*(13), 1170-1183.

Borden, L., & Perkins, D. (1999). Assessing your collaboration: A self evaluation tool. *Journal of*

  Extension, 37(2). Retrieved from http://www.joe.org/joe/1999april/tt1.html

Bruce, H., Fidel, R., Pejtersen, A. M., Dumais, S., & Grudin, J. (2003). A comparison of the

  collaborative information retrieval of two design teams. *New Review of Information*

  Behavior Research, *4*, 139-153.

Bryman, A. (2006a). Integrating quantitative and qualitative research: How is it done?

  Qualitative Research, 6, 97-113.

Byron, S. M., & Young, J. I. (2000). Information seeking in a virtual learning environment.

  Research Strategies, 17(4), 257-267.

Case, D. O. (2002). *Looking for information: A survey of research on information seeking, needs,*

and behavior. San Diego, CA: Academic Press.

Chatman, E. A. (1996). The impoverished life-world of outsiders. *Journal of the American Society for Information Science, 47*(3), 193-206.

Chatman, E. A. (2000). Framing social life in theory and research. *New Review of Information Behaviour Research, 1*(1), 3-17.

Chung, J. S., & Neuman, D. (2007). High school students' information seeking and use for class projects. *Journal of the American Society for Information Science and Technology*, *58*(10), 1503-1517.

Chrislip, D., & Larson, C. (1994). *Collaborative leadership*. San Francisco, CA: Jossey Bass.

Cole, C. (1997). Information as process: The difference between corroborating evidence and "information" in humanistic research domains. *Information Processing and Management, 33*(1), 55-67.

Cole, C. (1998). Information acquisition in history Ph.D. students: Inference and the information of knowledge structures. *Library Quarterly, 68*(1), 33-54.

Corti, L. (1993). Using diaries in social research. *Social Research Update*, *2*. Retrieved from http://www.soc.surrey.ac.uk/sru/SRU2.html

Curtis, D., & Lawson, M. (2001). Exploring collaborative online learning. *Journal of Asynchronous Learning Networks, 5*(1), 21-34.

Dervin, B. (1983, May). *An overview of sense-making research: Concepts, methods, and results To date*. Paper presented at International Communication Association annual meeting, Dallas, TX. Retrieved from http://communication.sbs.ohio-state.edu/sensemaking/art/artdervin83.html

Dervin, B. (1992). From the mind's eye of the user: The sense-making qualitative-quantitative

methodology. In J.D. Glazier & R.R. Powell (Eds.), *Qualitative research in information management* (pp. 61–84). Englewood, CO: Libraries Unlimited.

Dervin, B. (1994). Information democracy: an examination of underlying assumptions. *Journal of the American Society for Information Science, 45*(6), 369-85.

Dervin, B., & Nilan, M. (1986). Information needs and uses. *Annual Review of Information Science and Technology, 21*, 3-33.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds), *Learning in humans and machine: Towards an interdisciplinary learning science* (pp. 189-211). Oxford: Elsevier.

Dodd, L. (2007). The impact of problem-based learning on the information behavior and literacy of veterinary medicine students at University College Dublin. *Journal of Academic Librarianship, 33*(2), 206-216.

Ellis, D. (1989). A behavioral approach to information retrieval system design. *Journal of Documentation, 45*(3), 171-212.

Fidel, R., Bruce, H., Pejtersen, A. M., Dumais, S., Grudin, J., & Poltrock, S. (2000). Collaborative information retrieval (CIR). *New Review of Information Behavior Research: Studies of Information Seeking in Context, 1*(1), 235–247.

Fister, B. (1992). The research process of undergraduate students. *Journal of Academic Librarianship, 18*(3), 163-169.

Foster, J. (2006). Collaborative information seeking and retrieval. *Annual Review of Information Science and Technology*, *40*, 329-356.

Foster, J. (2009). Understanding interaction in information seeking and use as a discourse: a dialogic approach. *Journal of Documentation, 65*(1), 83-105.

Frey, B. B., Lohmeier, J. H., Lee, S.W., Tollefson, N., & Johanning, M. L. (2004). Measuring change in collaboration among school safety partners. In D. L. White (Ed.), *Persistently safe schools: Proceedings of the National Conference of the Hamilton Fish Institute on School and Community Violence* (pp. 63-72). Washington, DC: George Washington University.

Galison, P., & Hevly, B. (1992). *Big science: The growth of large scale research*. Stanford, CA: Stanford University Press.

George, C., Bright, A., Hurlbert, T., Linke, E. C., Claire, G., & Stein, J. (2006). Scholarly use of information: Graduate students' information seeking behavior. *Information Research, 11*(4). Retrieved from http://informationr.net/ir/11-4/paper272.html

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education, 7*(1). Retrieved from http://scholar.lib.vt.edu/ejournals/JTE/jte-v7n1/gokhale.jtev7n1.html

Handel, M., & Herbsleb, J. D. (2002, December). *What is chat doing in the workplace?* Paper presented at the ACM Conference on Computer Supported Cooperative Work 2002, New Orleans, LA. Retrieved from http://dl.acm.org/citation.cfm?id=587080

Hansen, P., & Jarvelin, K. (2005). Collaborative information retrieval in an information intensive domain. *Information Processing and Management, 41*(5), 1101–1119.

Hara, N., Solomon, P., Kim, S., & Sonnenwald, D. H. (2003). An emerging view of scientific collaboration: Scientists' perspectives on collaboration and factors that Impact collaboration. *Journal of American Society for Information Science and Technology, 54*(10), 952-965.

Henri, F. (1992). Computer conferencing and content analysis. In A.R. Kaye (Ed.), *Collaborative*

learning through computer conferencing: The Najaden papers (pp.117-136). Berlin: Springer-Verlag.

Hertzum, M. (2008). Collaborative information seeking: The combined activity of information seeking and collaborative grounding. *Information Processing and Management*, *44*(2), 957- 962.

Hogue, T. (1993). *Community-based collaboration: Community wellness multiplied*. Corvallis, OR: Oregon State University, Oregon Center for Community Leadership.

Holliday, W., & Li, Q. (2004). Understanding the millennial: Updating our knowledge about students. *Reference Services Review, 32*(4), 356-366.

Horvitz, E. (1999, May). *Principles of mixed-initiative user interfaces*. Paper presented at the ACM SIGCHI Conference on Human Factors in Computing Systems, Pittsburgh, PA. Retrieved from http://research.microsoft.com/~horvitz/uiact.html

Hyldegård, J. (2006). Collaborative information seeking – Exploring Kuhlthau's information search process-model in a group-based educational setting. *Information Processing and Management*, *42*(1), 276-298.

Hyldegård, J. (2009). Beyond the search process - Exploring group members' information behavior in context. *Information Processing and Management*, *45*(1), 142-158.

Hyldegård, J., & Ingwersen, P. (2007). Task complexity and information behaviour in group based problem solving. *Information Research*, *12*(4). Retrieved from http://InformationR.net/ir/12-4/colis/colis27.html

Iivonen, M., & Sonnenwald, D. H. (2000). The use of technology in international collaboration. In D.H. Kraft (Ed.), *Proceedings of the 63rd American Society for Information Science Meeting* (pp. 78-92). Medford, NJ: Learned Information, Inc.

Ingwersen, P., & Järvelin, K. (2005). *The turn: Integration of information seeking and retrieval in context*. Heidelberg: Springer.

Isbell, D., & Kammerlocher, L. (1998). Implementing Kuhlthau: A new model for library and reference instruction. *Reference Services Revie*w, *26*(3/4), 33-44.

Jahng, N., Nielsen, W., & Chan, E. K. H. (2010). Collaborative learning in an online course: A comparison of communication patterns in small and whole group activities. *Journal of Distance Education, 24*(2), 39-58.

Johnson, R. T., & Johnson, D. W. (1986). Action research: Cooperative learning in the science classroom. *Science and Children, 24*, 31-32.

Kagan, S. L. (1991). *United we stand: Collaboration for child care and early education service.* New York: Teachers College Press.

Karamuftuoglu, M. (1998). Collaborative information retrieval: Towards a social informatics view of IR interaction. *Journal of American Society for Information Science, 49*(12), 1070–1080.

Karen, S., Santacruz, M. D., & Swagerty, D. (2001). Early diagnosis of dementia. *American Family Physician, 63*(4), 717-718.

Karunakaran, A., Spence, P. R., & Reddy, M. (2010, February). *Towards a model of collaborative information behavior.* Paper presented at the ACM Conference on Computer Supported Cooperative Work 2010, Savannah, GA. Retrieved from http://workshops.fxpal.com/cscw2010cis/submissions/tmp10.pdf

Kennedy, L., Cole, C., & Carter, S. (1999). The false focus in online searching: The particular case of undergraduates seeking information for course assignments in the humanities and social sciences. *Reference and User Services Quarterly, 38*(3), 267-273.

Kim, J., & Lee, J. (2012a). Graduate students' information seeking in a collaborative learning

    setting. *Proceeding of the iConference 2012,* 552-554. doi:10.1145/2132176.2132285

Kim, J., & Lee, J. (2012b). Progressing through the stages of the ISP in a collaborative learning

    setting. In P. Resta (Ed.), *Proceedings of Society for Information Technology and Teacher*

    Education International Conference 2012 (pp.522-529), Austin, TX. Chesapeake, VA:

    AACE.

Kim, S., & Ju, B. (2008). An analysis of faculty perceptions: Attitudes toward knowledge

    sharing and collaboration in an academic institution. *Library and Information Science*

    Research, *30*(4), 282-290.

Kracker, J. (2002). Research anxiety and students' perceptions of research: An experiment. Part

    I. Effect of teaching Kuhlthau's ISP model. *Journal of the American Society for*

    Information Science and Technology, 53(4), 282-294.

Kraut, R. E., & Streeter, L. A. (1995). Coordination in software development. *Communications*

    of the ACM, 38(3), 69-81.

Krippendorff, K. (2012). *Content analysis: An introduction to its methodology* (3rd ed.).

    Thousand Oaks, CA: Sage.

Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the user's

    perspective. *Journal of the American Society for Information Science, 42*(5), 361- 371.

Kuhlthau, C. C. (1993). Implementing a process approach to information skills: A study

    identifying indicators of success in library media programs. *School Library Media*

    Quarterly, 22(1), 11-18.

Kuhlthau, C. C. (2004). *Seeking meaning: A process approach to library and information*

    services (2nd ed.). Westport, CT: Libraries Unlimited.

Kuhlthau, C. C., Heinström, J., & Todd, R. J. (2008). The 'information search process' revisited: Is the model still useful? *Information Research*, *13*. Retrieved from http://InformationR.net/ir/13-4/paper355.html

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2007). *Guided inquiry: Learning in the 21st century*. Westport CT: Libraries Unlimited.

Limberg, L. (1999). Three conceptions of information seeking and use. In T. D. Wilson & D.K. Allen (Eds.), *Exploring the contexts of information behavior* (pp. 116-135). London: Taylor Graham.

Mattessich, P. W., & Monsey, B. R. (1992). *Collaboration: What makes it work.* St. Paul, MN: Amherst H. Wilder Foundation.

Marchionini, G. (1995). *Information seeking in electronic environments*. NY: Cambridge U. Press.

Meloche, J. & Dalton, S. (2011, October). *Collaborative information seeking*. Paper presented at Collaborative Information Seeking (CIS) workshop, New Orleans, LA. Retrieved from http://collab.infoseeking.org/resources/papersCIS11/MelochePaper.pdf

Morris, M. R. (2008, April). *A survey of collaborative web search practices*. Paper presented at the ACM CHI 2008 Conference on Human Factors in Computing Systems, Paris, France. Retrieved from http://research.microsoft.com/enus/um/people/merrie/papers/collab_search_survey.pdf

Morris, M. R., & Horvitz, E. (2007, October). *Searchtogether: An interface for collaborative web search*. Proceedings of User Interface Software and Technology (UIST), Newport, RI. Retrieved from http://research.microsoft.com/en-us/um/people/horvitz/searchtogether _uist2007.pdf

Neuendorf, K. A. (2002). *The content analysis guidebook*, Thousand Oaks, California, Sage.

Neuman, D. (2001). Students' strategies for making meaning from web information.

In D. Kraft (Ed.), *Proceedings of the 64th Annual Conference of the American Society of Information Systems and Technology* (pp.1503-1517). Silver Spring, MD: American Society for Information Science and Technology.

Ntuen, C. A., Munya, P., Trevino, M. (2006, September). *An approach to collaborative sensemaking process*. Paper presented at the 11th International Command and Control Research and Technology Symposium, Cambridge, UK.

O'Farrell, M., & Bates, J. (2009). Student information behaviours during group projects: A study of LIS students in university college Dublin, Ireland. *Aslib Proceedings: New Information Perspectives*, *61*(3), 302-315.

O'Neill, J., & Martin, D. (2003, November). *Text chat in action*. Paper presented at the 2003 International ACM SIGGROUP conference on Supporting group work, Sanibel Island, FL. Retrieved from

http://bscw.cs.ncl.ac.uk/pub/bscw.cgi/d54985/Text%20Chat%20In%20Action.pdf

Marcella, R., & Baxter, G. (2000). An observational study of the information seeking behaviour of members of parliament in the united kingdom. *Aslib Proceedings, 52*(6), 207–217.

Panitz, T., & Panitz, P. (1998). Encouraging the use of collaborative learning in higher education. In James .J. F. Forest (Ed.), *University Teaching: International Perspectives* (pp. 161-202). New York: Garland Publisher.

Paul, S., & Reddy, M. (2010, February). *A framework for Sense-making in collaborative information seeking*. Paper presented at the ACM Conference on Computer Supported

Cooperative Work 2010, Savannah, GA. Retrieved from

http://www.personal.psu.edu /sap246/spaul_CISWorkshop_Final.pdf

Pennanen, M., & Vakkari, P. (2003). Students' conceptual structure, search process and

outcome while preparing a research proposal: A longitudinal case study. *Journal of the*

American Society for Information Science and Technology, 54(8), 759-770.

Pettigrew, K. E. (1999). Waiting for chiropody: Contextual results from an ethnographic study of

the information behavior among attendees at community clinics. *Information Processing*

and Management, 3(6), 801-817.

Pettigrew, K. E. (2000). Lay information provision in community settings: How community

health nurses disseminate human services information to the elderly. *Library Quarterly,*

70(1), 47-85.

Pettigrew, K. E., Fidel, R., & Bruce, H. (2001). Conceptual frameworks in information

behavior. *Annual Review of Information Science and Technology*, *36*(3), 43-78.

Pickens, J., Golovchinsky, G., Shah, C., Qvarfordt, P., & Back, M. (2008, July). *Algorithmic*

mediation for collaborative exploratory search. Paper presented at the ACM SIGIR 2008,

Singapore. Retrieved from

http://www.fxpal.com/publications/FXPAL-PR-08-460.pdf

Poltrock, S., Dumais, S., Fidel, R., Bruce, H., & Pejtersen, A. M. (2003, November). Information

seeking and sharing in design teams. *Proceedings of the ACM conference on supporting*

group work, 239-247. doi:10.1145/958160.958198

Prekop, P. (2002). A qualitative study of collaborative information seeking. *Journal of*

Documentation, 58(5), 533-547.

Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative

problem solving. In C. O'Malley (Ed.), *Computer supported collaborative Learnin*g (pp. 69-97). Berlin: Springer-Verlag.

Quan-Haase, A., Cothrel, J., & Wellman, B. (2005). Instant messaging for collaboration: A case study of a high-tech firm. *Journal of Computer-Mediated Communication, 10*(4), 120-121. Retrieved from http://jcmc.indiana.edu/vol10/issue4/quan-haase.html

Rieman, J. (1993, April).The diary study: A workplace- oriented research tool to guide laboratory efforts. *In Proceedings of INTERCHI' 1993,* 321-326. doi:10.1145/169059.169255

Reddy, M. C., & Jansen, B. J. (2008). A model for understanding collaborative information behavior in context: A study of two healthcare teams. *Information Processing and Management, 44*(1), 256-273.

Reddy, M. C., & Spence, P.R. (2008). Collaborative information seeking: A field study of a multidisciplinary patient care team. *Information Processing and Management, 22*(1), 242-255.

Schellens, T., & Valcke, M. (2006). Fostering knowledge construction in university students through asynchronous discussion groups. *Computers and Education. 46*(4), 349-370.

Schrage, M. (1995). *No more teams: Mastering the dynamics of creative collaboration.* New York: Currency and Doubleday.

Serola, S., & Vakkari, P. (2005). The anticipated and assessed contribution of information types in references retrieved for preparing a research proposal. *Journal of the American Society for Information Science and Technology, 56*(4), 373-381.

Shah, C. (2008, July). *Toward collaborative information seeking (CIS).* Paper presented at the Collaborative Exploratory Search workshop at JCDL 2008, Pittsburgh, PA. Retrieved from http://workshops.fxpal.com/jcdl2008/submissions/tmpE1.pdf

162

Shah, C. (2010, February). *Working in collaboration - What, why, and how?* Paper presented at

the Collaborative Information Retrieval workshop at CSCW 2010, Savannah, GA.

Retrieved from http://workshops.fxpal.com/cscw2010cis/submissions/tmp11.pdf

Shah, C., & González-Ibáñez, R. (2010). Exploring information seeking processes in

collaborative search tasks. *Proceedings of the American Society of Information Science

and Technology, 47*(1), 1-7.

So, H. J., & Brush, T. (2008). Student perceptions of collaborative learning, social presence and

satisfaction in a blended learning environment: Relationships and critical factors.

Computers and Education, 51(1), 318-336.

Sonnenwald, D. H. (1995). Contested collaboration: A descriptive model of intergroup

communication in information system design. *Information Processing and Management*,

31(6), 859-877.

Sonnenwald, D.H. (2003, November). Expectations for a scientific collaboratory: A case study.

*Proceedings of the 2003 international ACM SIGGROUP conference on supporting group

work*, 68–74. doi:10.1145/958160.958171

Sonnenwald, D. H. (2007). Scientific collaboration. In B. Cronin (Ed.), *Annual Review of

Information Science and Technology, 40*(6), 643-681.

Sonnenwald, D.H., & Lievrouw, L.A. (1997). Collaboration during the design process: A case

study of communication roles and project performance. In P. Vakkari, R. Savolainen & B.

Dervin (Eds.), *Information Seeking in Context* (pp. 179-204). London: Taylor Graham.

Sonnenwald, D. H., & Pierce, L. G. (2000). Information behavior in dynamic group work

contexts: interwoven situational awareness, dense social networks and contested

collaboration in command and control. *Information Processing and Management, 36*(3),

461–479.

Surowiecki, J. (2004). *The wisdom of crowds*. New York: Random House.

Swain, D. E. (1996). Information search process model: How freshmen begin research. In
Proceedings of the ASIS Annual Meeting, 33, 95-99.

Talja, S. (2002): Information sharing in academic communities: Types and levels of collaboration
in information seeking and use. *New Review of Information Behavior Research, 3*, 143
-159.

Talja, S., & Hansen, P. (2006). Information sharing. In A. Spink & C. Cole (Eds.), *New
Directions in Human Information Behavior* (pp. 113-134). Dordrecht: Springer.

Todd, R. J. (2006). From information to knowledge: Charting and measuring changes in students'
knowledge of a curriculum topic. *IR Information Research, 11*(4). Retrieved from
http://www.informationr.net/ir/11-4/paper264.html

Todd, R. J. & Heinstrom, J. (2006). Uncertainty and guidance: School students' feelings, study
approaches, and need for help in inquiring projects. *Scan, 25*(3) 29-35.

Todd, R. J., Kuhlthau, C. C., & Heinstrom, J. E. (2005). *School library impact measure (SLIM):
A toolkit and handbook for tracking and assessing student learning outcomes of guided
inquiry through the school library.* Center for International Scholarship in School
Libraries, Rutgers University. Retrieved from
http://cissl.scils.rutgers.edu/ guided_inquiry/docs/SLIM_toolkit.pdf.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). *Cooperative learning: A guide to research.*
New York: Garland.

Tuominen, K., & Savolainen, R. (1997). A social constructionist approach to the study of
information use as discursive action. In P. Vakkari, R. Savolainen & B. Dervin (Eds.),

Information seeking in context: proceedings of an international conference on research in information needs, seeking and use in different contexts 1996 (pp. 81-96). London: Taylor Graham.

Twidale, M. B., Nichols, D. M., & Paice, C. D. (1995, October). Supporting collaborative learning during information searching. *Proceeding of the international conference on Computer Supported Collaborative Learning 1995*, 367–374. doi:10.3115/222020.222831

Vakkari, P. (1999). Task complexity, problem structure and information actions: Integrating studies on information seeking and retrieval. *Information Processing and Management, 35*(6), 819-837.

Vakkari, P. (2001). A theory of the task-based information retrieval process: a summary and generalization of a longitudinal study. *Journal of Documentation*, *57*(1), 44-60.

Vakkari, P., Pennanen, M., & Serola, S. (2003). Changes of search terms and tactics while writing a research proposal: A longitudinal case study. *Information Processing and Management, 39*(3), 445-463.

Valentine, B. (1993). Undergraduate research behavior: Using focus groups to generate theory. *Journal of Academic Librarianship, 19*(5), 300-3004.

Vidmar, D. J. (1998). Affective change: Integrating pre-sessions in the students classroom prior to library instruction. *Reference Services Review*, *26*(3/4), 75–95.

Weinberg, A.M. (1961). Impact of large-scale science on the United States. *Science*, *134*(3473), 161-164. doi:10.1126/science.134.3473.161

Wilson, T. D. (1999). Models in information behaviour research. *Journal of Documentation*, *55*(3), 249-270.

Wildemuth, B.M. (2002). Effective methods for studying information seeking and use. *Journal of the American Society for Information Science and Technology, 53*(14), 1218-1222.

Yang, S. (1997). Information seeking as problem-solving using a qualitative approach to uncover the novice learners' information seeking process in a peruse hypertext system. *Library and Information Science Research, 19*(1), 71-92.

Yue, Z., & He, D. (2010, February). *Exploring collaborative information behavior in context: A case study of E-discovery*. Paper presented at the ACM 2010 conference on Computer Supported Cooperative Work 2010, Savannah, GA. Retrieved from http://workshops.fxpal.com/cscw2010cis/submissions/tmpA.pdf

Zhao, J., Li, K., & Kanji, A. (2001, October). *Modeling and system design for Web-based Collaborative Learning*. Paper presented at the 2nd International Conference on Information Technology Based Higher Education and Training, Kumamoto, Japan. Retrieved from http://www.eecs.kumamoto-u.ac.jp/ITHET01/proc/084.pdf